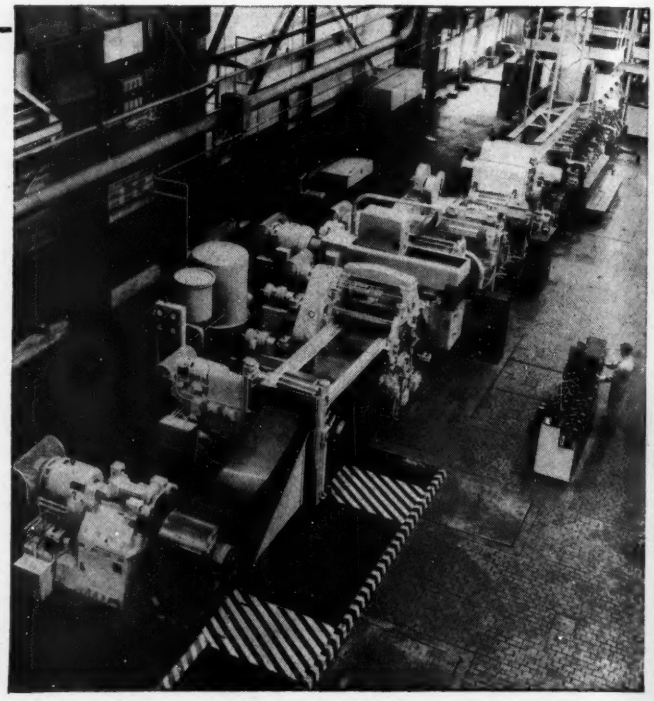
THE CORNELL ENGINEER

COLLEGE OF ENGINEERING · CORNELL UNIVERSITY

Electrolytic tinning process stretches tin supply

—makes better, less expensive tin-plated products

•pioneered by Carnegie-Illinois Steel Corporation



Before the war, almost all tin plate was made by the hot-dip method in which a sheet of steel was coated by dipping it into molten tin. In the 1930's, Carnegie-Illinois Steel Corporation, a member of the United States Steel family, played an important role in the research work and the technological development of the *electrolytic process*—an improved tinning method in which a strip of steel is given a thin, uniform coating of tin by passing continuously and rapidly through a bath of special plating solution. This process necessitated the development, by Carnegie-Illinois engineers, of complex mechanical equipment completely revolutionary in the industry.

Since the electrolytic process covers a given area of steel with only one-third the amount of tin that the hot-dip method requires, it makes the tin supply go 3 times as far.

Today, United States Steel Corporation has nine electrolytic tin-plating lines producing U·S·S Ferrostan. These lines are helping to lower the cost of tin-plated steel . . . stretch the supply of tin—and make better tin-plated products.

Opportunities

Work such as this has an important place in the operations of all U. S. Steel Subsidiaries. To be carried out successfully, these undertakings require qualified technical men. Why not see your Placement Officer about the book "Paths of Opportunity in U. S. Steel" and find out how you can take part in this interesting, important work?

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USS

UNITED STATES STEEL

Founded 1885

The CORNELL ENGINEER

Volume 14 February, 1949 Number 5

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Cover: Traditional nocturnal winter scene. Library and clock tower with Sage Chapel just visible to the left.

Member of The Engineering College Magazines Associated
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Pennsylvania Triangle
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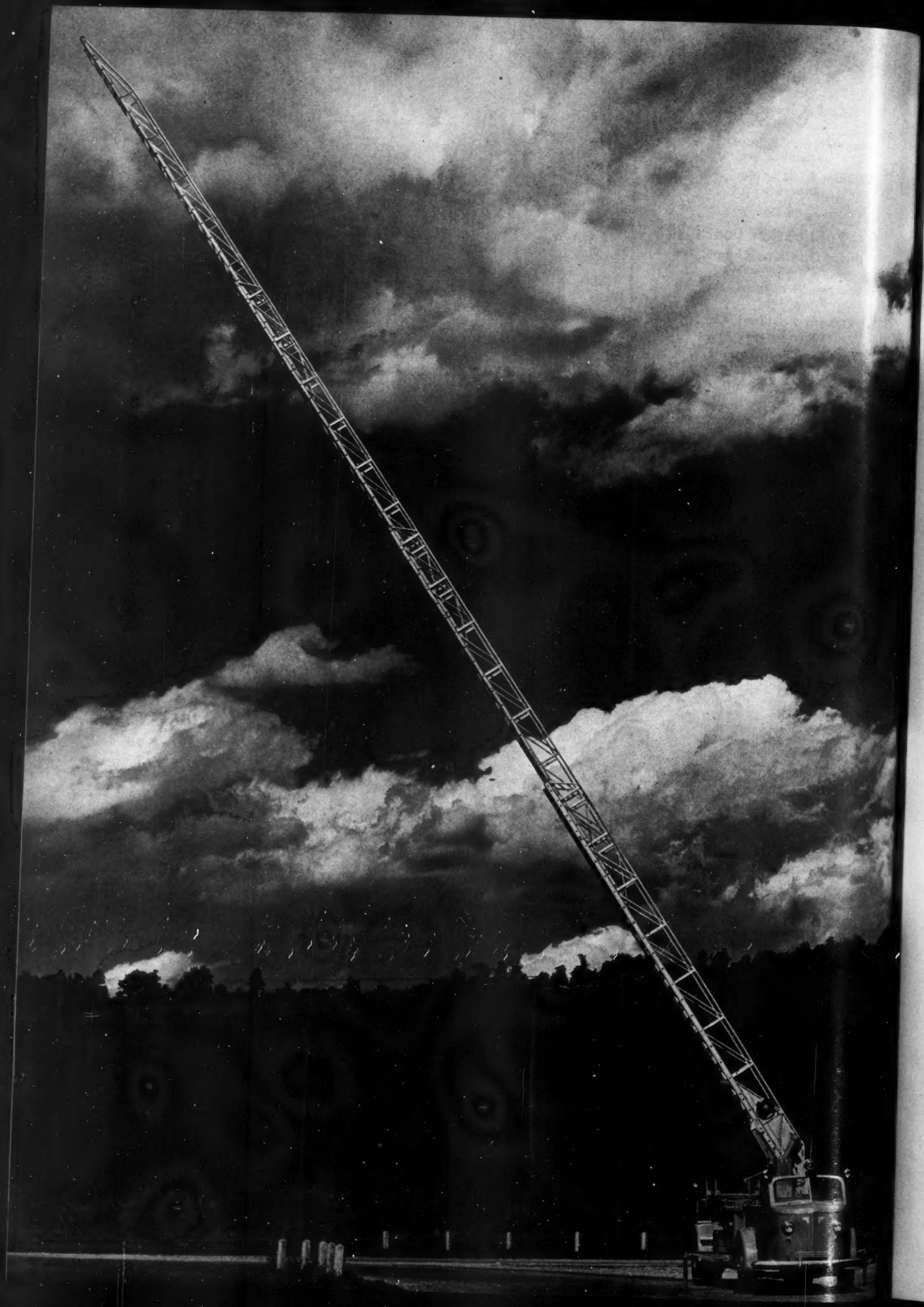
Published monthly—October to May—by the Cornell Engineer, Inc., Lincoln Hall, Ithaca, N. Y. Edited by the undergraduates of the College of Engineering. Cornell University. Entered as second class matter at the Post Office at Ithaca, N. Y., under Section 103, Act of October 3, 1917.

Subscription per year: regular $2.00; with membership in the Cornell Society of Engineers $3.00 (See President's page); student $1.50; single copy $.25.



Voice of The Worker

By CLYDE H. LOUGHRIDGE, JR., M.E. '43

Photographs courtesy Lincoln Electric Company

WHY is the voice of the factory worker so important today? In the first place these voices represent 23 percent of the working people in the United States. Secondly, this self-expression is a real need both from the worker's and from management's viewpoint.

The worker experiences an ever increasing need to express himself in an attempt to exercise some influence over the conditions of his security. The urban factory worker is completely dependent upon his job for the livelihood of himself and his family. Because the security of his way of life depends on the job, the job itself becomes of paramount importance in his life. When he has no voice in affairs pertaining to that job, he feels insecure. He feels that his family can have its life line snapped off through no fault of his own, and without his having any recourse, or even a chance to plan for a change. It is no wonder that workers feel a great need to have a voice in their job.

Recognition for Ideas

Another reason for a worker's need of self-expression is that a large part of the satisfaction obtainable from a job is in the form of recognition for ideas contributed. It is true that money is the greatest determiner of status in our culture, yet among those receiving equal pay the individual whose ideas and suggestions are accepted by management has greater status. Especially is this form of satisfaction needed in the increasing number of jobs requiring a low level of skill. In these unskilled, repetitive jobs there can be relatively little pride of workmanship taken, as each worker contributes a short operation to a large number of like pieces instead of making all the pieces and receiving the satisfaction of assembling them all into a complete unit. But even though a worker is faced with a repetitive job, he can still receive non-monetary satisfaction from the job if he is encouraged to make suggestions and is given recognition for them.

A third reason for a worker's need of expression is that he feels better when his complaints have been listened to. He feels that management is interested in him and in his welfare. Frequently the mere expression of his grievance will point the way to a solution. Or it may

Jutting into the sky is the 100-foot ladder of one of the new types of ladder trucks. Constructed of seamless steel tubing and employing welded construction throughout, this ladder was designed largely through the efforts of the late Professor C. E. O'Rourke (see page 17).

THE AUTHOR

A former managing editor of the CORNELL ENGINEER, Clyde H. Loughridge, Jr., has been employed as an industrial engineer at the Lincoln Electric Company for the past two years, where he has studied the problems of labor representation. After graduating from the School of Mechanical Engineering in 1943, he was a captain in the Army Security Agency and did development work on signal security equipment.

Mr. Loughridge came to Cornell from Lakewood, Ohio, with a McMullen Scholarship. Here he received his commission in the Signal Corps on completion of the advanced ROTC course. During his undergraduate days, he was a member of Tau Beta Pi, Sphinx Head, Scabbard and Blade, and Atmos.

Clyde H. Loughridge, Jr.

cause the worker to realize that it is really something else which is bothering him. In either case, expression is the basis for solution. Repression of his complaints leaves the worker dissatisfied, uncooperative, and sometimes even hostile.

Workers Ideas Essential

From management's viewpoint, the ideas of the workers are essential for efficient production. There is no doubt that the worker on the job knows more about certain phases of it than does management or the foremen, or the engineers for that matter. This knowledge is wasted if it is not brought to the attention of management through worker expression.

A meeting of the Lincoln Electric advisory board. Such a board, composed of elected employee representatives, the personnel director, superintendents, and the general manager, has as its purpose the settling of employee grievances.

Furthermore, management needs the cooperation of all workers for a smooth functioning organization. This type of cooperation is elicited when workers are given a voice in company affairs, and is turned into hostility when they are dictated to.

Many of the mistakes made by management are the result of its not being properly informed as to the attitudes and sentiments of the workers toward the work situation. It is therefore essential that management have an accurate and complete picture of the entire organization at all times. This can be accomplished only through accurate transmission of information to top management either up the line of authority or by some other means.

Communications Up The Line Of Authority

It is the purpose of this article to discuss the various means and channels by which workers may communicate their grievances or ideas to management for their mutual benefit. We shall first consider the channel formed by the line of authority from the worker up to the president. This line may include the foreman, department chief, division chief, superintendent, and president. This is the normal channel of communication, and is relied upon to a large extent for most information on the activities of the factory. However, its successful functioning is limited for several reasons. It is dependent upon the state of personal relationships between workers and their foreman, and between each of the other levels in the line. Thus, a foreman who does not show an interest in workers' problems blocks the channel at the start. Or if the foreman carries a grievance to the department chief, he may get no response from him, depending again upon the state of personal relations between these two individuals.

Another limitation on this channel of communication is the sifting or filtering which is done at each level. No one would argue that this should not be done to a certain extent, as the president is not in a position to receive all the complaints or suggestions received by all foremen. However, it is unavoidable that individuals in the line will place more emphasis than they should on some things at the expense of others due to their personal bias or lack of understanding the complete picture.

It is also well known that information and requests which are passed up the line are frequently selected on the basis of how it will affect the standing of the individual passing the information. For example, if a worker complains about poor lighting, and the department chief had been directed by the division chief to remedy this condition two months ago, it is not likely that the complaint will go further up the line than the department chief.

In some organizations this line of authority is long and complicated, making it difficult to maintain the accuracy of the original transmission, and making it possible for a person in the line to adopt another's idea as his own.

Some companies have the policy or permitting any factory worker to take the initiative and come to the president's office with a suggestion or grievance. This is not an effective means of communication because of the worker's hesitancy to make a personal appearance in the president's office.

An example of the way one company handled this problem of direct communication between worker and president is provided in the questionnaire mailed to the home of each of the 1000 employees of the Lincoln Electric Company of Cleveland, Ohio. In answering it, each worker had the opportunity to express himself anonymously or otherwise, knowing that his honest opinions and suggestions would be read by the president himself.

Communications to the Personnel Department

In addition to contacts within the line of authority, the worker has numerous means of communication upwards outside the line of authority. These outside contacts may be classified as either direct or indirect, depending upon whether the employee states his own case personally, or whether it is stated through his representative. We shall consider the direct channels first.

The personnel department of most companies provides a useful channel of communication. Here the worker can usually find a group of people whose express purpose in the organization is to hear his personal or job problems and to help

A factory suggestion box. The suggestion system is a direct means of worker communication to management, and the improved employee morale resulting from such a system has made it widely used in industry. The opportunity for the individual worker to *sell* ideas directly to top management and also to receive recognition for it benefits both the employee and the company.

him adjust to either physical or social change in the factory.

However, if worker requests involve some revision or change in company policy, the personnel department may have difficulty in persuading management to act favorably upon the request. When the personnel department sides with the workers, it finds itself bucking management. On the other hand if it is management conscious and continually tries to sell the workers on the fairness of management's present policy, it will not have the confidence of the workers, and they will feel the need of other channels of expression which are open minded.

Employee Counselling

It is appropriate at this point to mention the counselling technique developed from studies made at the Hawthorne Works of the Western Electric Company by company officials and faculty members of the Harvard Graduate School of Business. Although in itself counselling is not a direct channel of communication up the line, it serves two purposes. First it provides management with an accurate overall picture of employee morale, and in this sense is an indirect means of communication. Secondly, it has proven to be a more effective way of assisting workers in their personal adjustments than the former method of personnel office advice.

The mechanics of the program are simply to provide a person for each department to whom workers and supervisors alike may go for a discussion of their problems. This counsellor is not in a position of any authority whatsoever, and keeps all workers' statements absolutely confidential, relaying to management only general conclusions as to the state of morale, or types of complaints which seem to occur most frequently.

In the case of a maladjusted individual, the counsellor listens patiently and with interest to all that the worker has to say, drawing him out in the areas where the trouble seems to lie. This conversation in itself helps the worker to see the answers to his own problems. The counsellor aids in this by directing the thoughts of the worker into areas which he will have to consider in order to find a solution.

It is interesting to note that here is a channel for communicating problems of a more personal nature than workers were apt to bring before a personnel advisor. Here also is a means of getting below the surface of a complaint to find out what its real cause is, so that progress can be made towards a lasting, instead of temporary, solution.

Suggestion Systems

The well known suggestion system offers another means by which workers may express themselves directly. One of the greatest benefits of this system is the improved employee morale resulting from the opportunity to sell ideas directly to top management and receive recognition for it.

The grapevine represents a haphazard, informal, inaccurate, but necessary method of communication. It is haphazard in that it follows no definite path and seldom reaches top management. It is informal in that grapevine communiations may take place in washrooms, beer parlors, or at the country club between people of any rank in the organization. That they are inaccurate is obvious from the fact that no person retells a story exactly as he heard it, and distortions and changes occur with every retelling. I say that it is a necessary part of the communication system because it helps to make workers feel important. When one has some "inside" information, he can become the center of interest by relating the news to his friends. When this information becomes distorted, and false rumors are circulated, production is adversely affected. This points to the need for adequate formal means of communication. In general, the grapevine serves to keep everyone informed of developments in other parts of the factory.

Union Communications

We shall next consider indirect means of worker communication. These employ a worker representative, and include the union grievance procedure, and the employee board system as represented by the Advisory Board at the Lincoln Electric Company.

(*Continued on page* 32)

Workers reading minutes of advisory board meetings. Posting of the minutes throughout the plant enables employees to check on the action of the board on specific complaints and suggestions.

MILES OF
PERFECTION

Rayon Manufacture by The Continuous Process

By BERNARD N. ROTH, ME '51

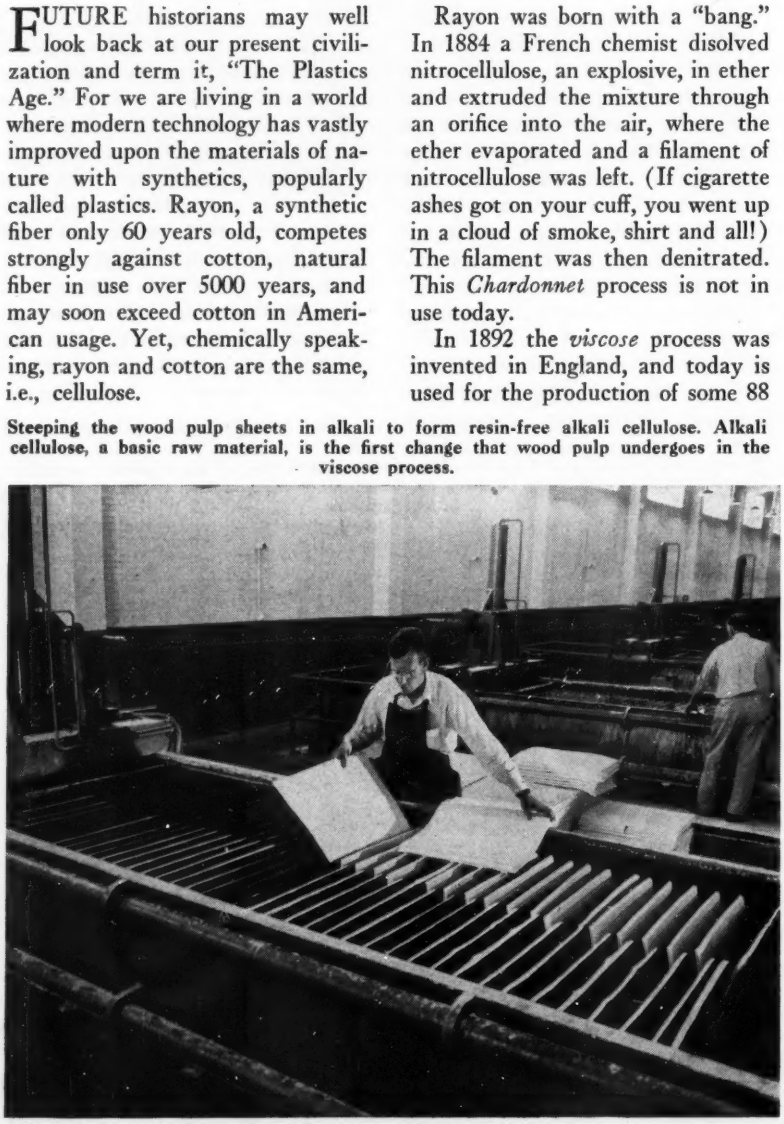
Photographs courtesy Industrial Rayon Corporation

FUTURE historians may well look back at our present civilization and term it, "The Plastics Age." For we are living in a world where modern technology has vastly improved upon the materials of nature with synthetics, popularly called plastics. Rayon, a synthetic fiber only 60 years old, competes strongly against cotton, natural fiber in use over 5000 years, and may soon exceed cotton in American usage. Yet, chemically speaking, rayon and cotton are the same, i.e., cellulose.

Rayon was born with a "bang." In 1884 a French chemist disolved nitrocellulose, an explosive, in ether and extruded the mixture through an orifice into the air, where the ether evaporated and a filament of nitrocellulose was left. (If cigarette ashes got on your cuff, you went up in a cloud of smoke, shirt and all!) The filament was then denitrated. This *Chardonnet* process is not in use today.

In 1892 the *viscose* process was invented in England, and today is used for the production of some 88 percent of the world supply of rayon. Like Chardonnet rayon, viscose rayon is a regenerated cellulose; that is, it is cellulose chemically processed into a solution, and then extruded to a fiber and changed to cellulose once more.

Steeping the wood pulp sheets in alkali to form resin-free alkali cellulose. Alkali cellulose, a basic raw material, is the first change that wood pulp undergoes in the viscose process.

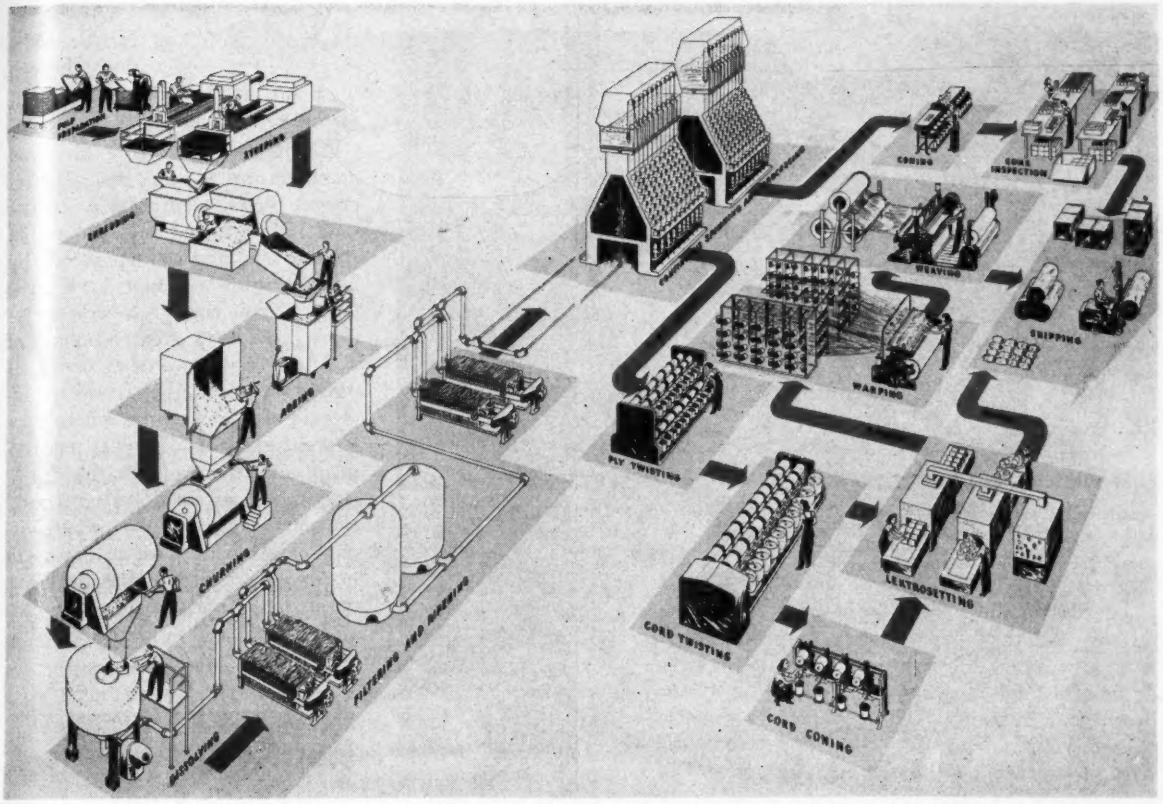


Wood Pulp Is Cellulose Source

The production of viscose rayon starts with wood pulp as the source of cellulose. Wood pulp is received as white sheets looking like blotting paper, and is first batch blended with other lots of pulp to obtain a uniform pulp. The pulp is steeped in sodium hydroxide to remove soluble impurities and to accomplish the first chemical change in the cellulose, converting it to alkali cellulose, which has absorbed approximately twice its former weight of caustic and water.

The wet sheets are then shredded by large revolving blades, which forms a product resembling breadcrumbs. To further the alkali reaction in the wet stage, the crumbs are then aged at about room temperature for about fifty hours in large cabinets, temperature controlled, because the viscose process is a cold process, 18-35°C being the usual range for most operations.

After aging, the crumbs are placed in a large churn; carbon disulfide is added, and the alkali cellulose reacts to form cellulose xanthate, which is soluble in alkali solution. The xanthate is mixed with a weak water-alkali solution



Flow sheet for continuous rayon production.

and becomes the orange syrup known as dissolver viscose.

Before dissolver viscose can be transformed to rayon filaments it must be aged and filtered through a succession of fine filters. All through the process the temperature is controlled, samples taken, and efforts are made to keep the viscose uniform from batch to batch. In aging the syrup, batches are mixed and aged together. Ageing continues until the solution has the right consistency and the right salt index or degree of esterification for spinning. In the last ageing tank, a vacuum de-aerates the syrup to keep bubbles from clogging the small spinning openings.

Macroscopic closeup of a rayon spinneret. 80 jets of viscose solution harden into rayon filament fibers in the reactive acid bath.

Pumped Through Tiny Orifices

Spinning takes its cue from the silk-worm; rayon solution is pumped through tiny orifices in a precious metal alloy cup known as a spinneret into an acid-salt bath, which regenerates the cellulose, as a monofilament (single fiber) or multifilament (many fibers, as a standard textile yarn). As each stream of syrup comes from a hole in the spinneret (named in honor of the silkworm's apparatus) into the warm acid bath, it hardens into a filament. The many filaments from each spinneret form a multi-filament yarn.

At this point in the process, the handling methods begin to differ. The older methods of treating the rayon were to collect the rayon from the spin bath in a spinning pot where it is coiled into a "cake" by centrifugal force, or to collect the rayon onto a spool; the various finishing treatments were then performed to the yarn in this package form. The objections to this form of handling were that the yarn got non-uniform treatment; that is, liquid processing as washing, neutralizing or bleaching, lubricating, does not wet the yarn inside the package as thoroughly as the outside yarn, and drying is also spotty. Then too, the handling of the wet packages between operational processes led to breakage and stress in the filaments, and knots, weak spots, variance of finish were obtained, all of which created snags in the weaving or knitting of rayon into cloth, and also in the dyeing of rayon fabric.

In the early 1930's, the Industrial Rayon Corporation of Cleveland, Ohio, recognizing the great need for some better method of handling and treating rayon between the spinneret and the final yarn package, put a research team to work on the problem. A new *continuous* process for handling rayon, was developed, and a rayon plant engineered to accommodate the new process was put into operation in 1938.

Alkali cellulose crumbs being emptied from a shredder. The load of crumbs is weighed and sampled in the car, and then chuted through the floor to the ageing rooms, for further reaction between alkali and alpha-cellulose.

The continuous process is based on the fact that if a rayon yarn is singly passed through a stream of process fluid at a constant velocity, the treatment of the yarn will be uniform. Yarn from the spin bath is treated as the individual strand advances to be taken up on a bobbin or spool. All the intermediate treatments and the final drying are performed on this individual strand, obtaining a uniform treatment, a minimum of transfer and handling, with a minimum of knots and broken filaments.

Heart of the Mechanism

The heart of the continuous process is the mechanism for yarn advancement developed by the research team. It is a set of two reels, both on the same axle, one inside the other, and rotating in the same direction about a pair of skewed axes. This reel is simply a kinematic expansion of a pair of skewed pulleys and a belt, the pulleys being the reel and the belt the rayon yarn, always advancing, never crossing strands, moving evenly.

The machine for continuous processing of rayon is a gigantic vertical A-bank, three stories high, of reels and spouts for treating fluid, and drip pans and pumps to recirculate the fluids. At the top are the spinnerets and spin baths. The middle section processes the rayon according to its final usage, and the lowest section drys and twists the rayon. The rayon filaments are advanced through the treating fluids and dryers and twisting mechanisms by means of the reel, insuring even, positive travel. Over the expanse of Industrial Rayon's spinning and processing department floor, these huge machines stretch out to the extremes in orderly rows.

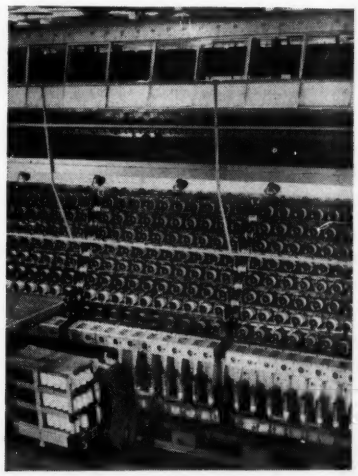
After spinning, the rayon filaments are taken up on a reel, and begin their journey through the various treatments. At the first stage it is treated with acid-salt solution of weaker strength to further the original spin bath reaction. Then it is desulphurized, bleached, oiled, and dryed. Between each successive treatment, excess treating fluid is removed by a washing process, preventing contamination of the next treatment.

According to whether the rayon is for tire cord or for textile yarn, the bobbins from the continuous process machine are taken to be twisted into cord or coned and inspected respectively. The twisted cord may be further woven into tire fabric. In one of these three forms, it is shipped to textile manufacturers and the tire industry.

Gravity Flow Utilized

Industrial Rayon's Painesville plant, designed for the continuous process, is a beautiful example of plant engineering. Gravity flow is extensively used, quality control is kept almost automatically, and the plant space, while quite extensive, is not wasted. The main raw materials, wood pulp and caustic soda, enter at one point, flow through the plant, and exit at another point as finished rayon.

An interesting feature of rayon manufacture is the recovery of caustic soda from waste caustic soda solutions and the recovery of sulfuric acid and sodium sulfate by crystallization of spin bath. The perfection of these recovery operations provides a great economy of raw material, and the saving is passed on to the user. In the manufacture of rayon, temperatures must be controlled at all points, necessitating extensive refrigeration facilities, as well as controlled air conditions in parts of the plant where viscose or alkali cellulose are aging or otherwise exposed to the air. Temperature and relative humidity control are required in textile areas for the finished rayon.



Continuous spinning and processing machine for the production of viscose rayon. Three stories high, it spins and processes miles of unbroken rayon.

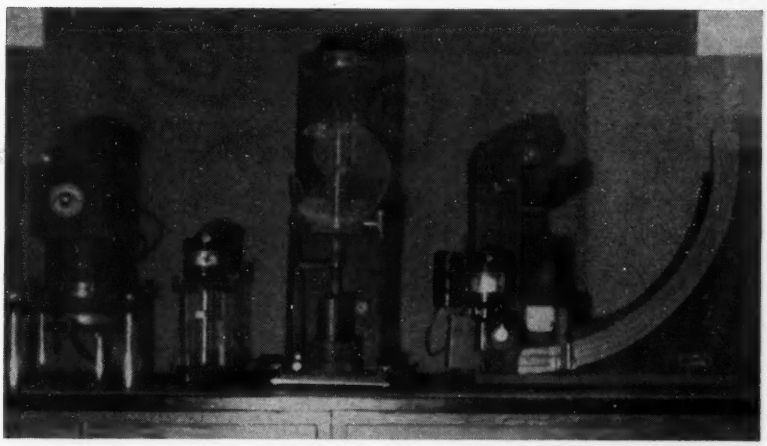
Rayon, while essentially a chemical process in a chemical industry, uses the assistance of other branches of engineering besides chemical engineering. Air conditioning and refrigeration, plant heat, power, water purification, waste disposal, industrial management—all are necessary technical "assists" in rayon production. Industry and technology, working together, are producing rayon for textiles, tires, and other purposes, a rayon uniform and perfect, in a widening stream, literally, miles of perfection.

ACTUAL MOLD CONDITIONS APPROXIMATED IN TESTS

Elevated Temperature Sand Research Project at Cornell

By JOHN P. FRASER, B.Chem. E. '47

THE use of metals has paralleled the development of civilization since the dawn of history, and ever since the earliest days, men have been interested in forming metals into intricate shapes. Many different methods are in use today, such as forging, casting, and welding, but one of the most important of all, on a tonnage basis, is casting. And of the casting techniques available, the most important is also the oldest —sand casting. Today, approximately 17 percent of all finished and semi-finished metal parts are cast; and sand casting accounts for about 86 percent of all the castings made.



Apparatus used for routine tests at room temperature of molding-sand properties.

Specialized Molding Sands

As a result of the widespread use of castings, there has always been, of course, a continuous demand for sands to be used in making the molds, and these molding sands turn out to be very specialized materials. To give some idea of the properties desired, a molding sand must pack readily around the pattern (which is roughly the same size and shape as the desired finished article), be strong enough to support its own weight after the pattern is removed, be refractory enough to retain its shape when full of molten metal, be porous so that gases liberated from the freezing metal and also any entrapped gases may escape from the mold cavity, present a fairly smooth surface to the molten metal, since the surface finish of the completed article depends on the mold surface, resist erosion as the metal is poured, resist surface buckling due to the expansion of the sand caused by large thermal gradients from the mold face back into the body of the sand, and finally, after the metal has solidified, the sand must be friable enough so that the finished casting can be easily cleaned.

In the early days, and up until the beginning of the twentieth cen-

THE AUTHOR

Since the fall of 1947, John P. Fraser has been working on the Elevated Temperature Sand Research Project, which has its headquarters in Olin Hall. Born in Evanston, Illinois, in 1924, he moved to California in 1936. In 1942, however, he received a John McMullen Regional Scholarship, which induced him to come back East to Cornell to study chemical engineering.

During the War, John served in the Navy, but he returned to Cornell in 1946 to finish his work towards the degree of B. Chem. E. His graduate work, in preparation for a Ph.D. in Metallurgy, has been chiefly directed towards this project, which is being sponsored by the American Foundrymen's Society.

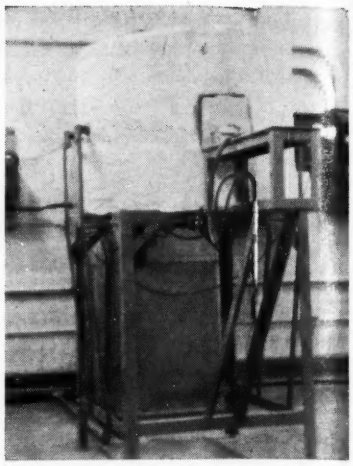
John P. Fraser

tury, the only sands used were naturally-occurring silica sands which also contained relatively high percentages of clay minerals, and these worked fairly well. Unfortunately, two successive shipments of sand, even from the same deposit, never gave the same results, so that the molding techniques had to be varied with each shipment, with a resulting loss of time and money. Finally, foundrymen began using "synthetic" sand mixtures, in which a definite weight of sand, free from clay, is mixed with definite proportions of other ingredients. These, for molding sand, may include various clays, water, wood flour, silica flour, finely divided coal, and many others.

The introduction of controlled molding-sand compositions, although it greatly improved foundry results, was not the final answer; for it was found that consecutive shipments of the ingredients varied —and even day-to-day work with the same sand did not produce entirely consistent results. A number of routine tests were developed, as a result, for control purposes, a good portion of the work in this country being performed at Cornell by Dr. H. Ries, and others. These tests include a compressive strength test, a test for moisture content, "permeability" testing (measuring the resistance to the passage of air through a standard specimen), and a test for clay content.

Elevated Temperature Tests

All of these tests are conducted at room temperature, and it was soon discovered that the test, although extremely useful, could not be satisfactorily correlated in all cases with the behavior of a sand in a mold. In fact, of two sands giving essentially identical room-temperature test results, one might be satisfactory for a certain application where the other would be entirely unsatisfactory. For this reason considerable effort has been made to develop tests to be conducted at elevated temperatures, approximating mold conditions. To mention a few, these include the hot compressive strength test, in which a cylindrical specimen is heated in a dilatometer and, while hot, tested in compression to failure; expansion testing, conducted in a number of different ways, on vertical as well as horizontal specimens, using both mechanical and optical measuring systems; a hot permeability test; a sintering test to see if the sand grains will adhere to a hot platinum strip; and many others.



Furnace used for expansion studies of sand mixtures. Heated electrically, the furnace can be operated up to temperatures of 2700°F.

A dilatometer, developed at Cornell, in use in Olin Hall. The incorporation in this equipment of a furnace built around the test specimen enables the compressive strength of a heated sample to be determined.

Research Work at Cornell

The American Foundrymen's Society has been one of the most interested bodies in developing elevated temperature tests, and since 1937, this Society has sponsored the *Elevated Temperature Sand Research Project* at Cornell. The work of the Project has been primarily concerned with a detailed study of the fundamental properties of molding sands, the mechanisms behind these observed properties, and their bearing on some of the defects

(*Continued on page* 30)

On the Early History of the Circular Slide Rule

. . . IN WHICH WE LEARN OF THE YET-VEHEMENT CONTROVERSY PRECIPITATED BY A LONDON WALK ONE DAY IN 1630—TOGETHER WITH A CRITICAL ANALYSIS BY THE AUTHOR OF THIS ENMITY WHICH MUCH AFFECTED THE LIVES OF THE REV. OUGHTRED AND ONE RICHARD DELAMAIN.

By HERBERT F. SPIRER, EP '51

In criticizing the first edition of a book by a colleague and friend, the Reverend William Oughtred, distinguished clergyman and famous mathemetician, described the book in the following terms:

"In reading it . . . I met with such a patchery and confusion of disjointed stuffe, that I was stricken with a new wonder, that any man should be so simple, as to shame himselfe to the world with such a hotch-potch."

The book subject to this acid criticism was the *Grammelogia,* or *Mathematical Ring,* by Richard Delamain. The mathematical ring that the title speaks of was a circular logarithmic slide rule. This book was the first publication revealing to the world the invention of a circular slide rule. The author, a teacher of mathematics, described several variations as well as giving complete information concerning an excellent working model. He showed considerable ingenuity and skill as a designer of slide rules.

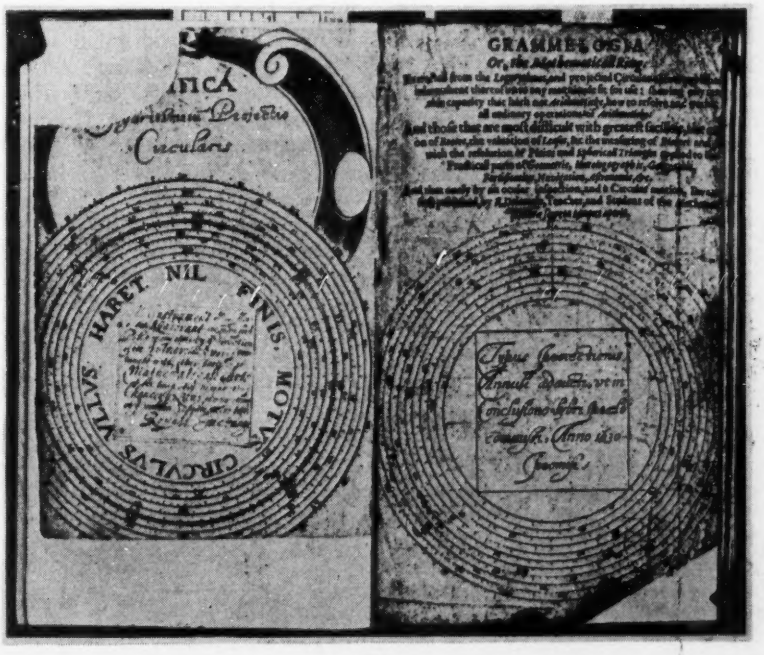
However, in speaking of the author, Reverend Oughtred said this: "[his course] is that of an ill-natured man with a virulent tongue, sardonical laughter and malapert sawsiness."

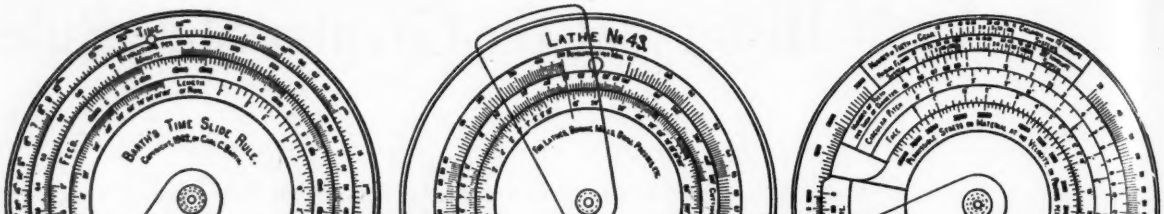
I shall attempt in this article to show what the nature of the controversy between Oughtred and Delamain was, and present my conclusions concerning the invention of the circular slide rule. In order to do this I shall show you the characters of Richard Delamain and William Oughtred as I have reconstructed them from their writings and the comments of their contemporaries, and give a chronological account of the major events in their friendship and the subsequent enmity.

A Background of Progress

The controversy between William Oughtred and Richard Delamain took place against a background of progress and great strides in the realm of applied mathematics. In 1614 John Napier, Baron of Merchiston in Scotland had invented logarithms for computation, and a few years later Briggs had suggested the change to the base ten. In 1620 Edmund Gunter had placed numbers along a line where the distances between numbers were proportional to the logarithms of the numbers, and was using these lines for multiplication and division. The disadvantage with Gunter's Lines was that to perform these operations it was necessary to add and

The title page of an edition of Richard Delamain's *Grammelogia,* or *Mathematical Ring.* One of Delamain's versions of the circular rule is illustrated on this title page. Note the variety of scales which appear on this rule, which was one of the first to appear.





Some more recent variations of circular slide rules. These circular rules are special purpose instruments and are designed for solving certain specific, often repeated, calculations that arise in machine shop operation. The huge growth in industry and the consequent change in technique and machinery since these rules were designed has made them obsolete, but other rules have taken their place.

subtract distances along the lines with dividers. This may seem like an obvious and trivial step today but at that time no one had done it before, and it was an original and creative development of great importance. All of the early development of the slide rule was done in England and Scotland.

One of the more famous mathmeticians of the day was the Reverend William Oughtred, who was known throughout the scientific world for contributions to trigonometry, astronomy, numerical computation, and theoretical subjects. He had a large following of students, who stayed with him for several years to acquire some of his knowledge and technique. His position as a man of science and pedagogue had brought him respect, and he bore himself with dignity. His moral and professional character was untarnished.

He was a strong believer in mathematics for its own sake. He felt that computing aids were to be avoided. When explaining to one of his pupils why he did not release earlier to the world his invention of the circular slide rule, he said:

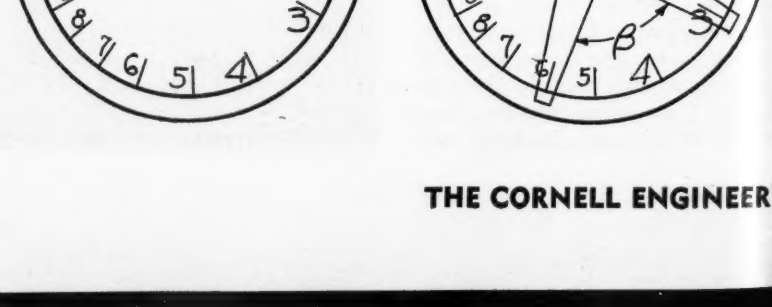
"That the true way of Art is not by Instruments, but by Demonstration: and that it is a preposterous course of the vulgar Teacher, to begin with Instruments and not with Sciences, and so instead of Artists to make their Scholars only doers of tricks, and as it were Juglers: to the despite of Art, loss of precious time, and betraying of willing and industrious wits unto ignorance and idleness."

Little-Known Private Life

Of Richard Delamain's private life we know little. He apparently had few friends, and unlike Oughtred who had a Socratic following and did not depend on teaching mathematics for a living, Delamain was known as a teacher of Mathematics. We do know that he designed and made several instruments, sundials, quadrants, and the like, for King Charles I, and they were favourably received. He served as tutor in mathematics to the king, and was a military engineer in the king's service. He did considerable practical work of an engineering nature, designing fortifications and surveying. It was while in military service that he died, after which his wife, penniless, petitioned the king for a pension for herself and the ten children.

It is evident from his writings on the slide rule and the other mathematical instruments, that he was extremely ingenious in designing instruments. He was primarily an engineer. He liked to do things, to find easier ways of calculating, and was more interested in the correct result than the beautiful method. In the dedication to the king in the *Mathematical Ring*, he emphasizes how

(*Continued on page* 24)



Illustrating the operation of one version of the circular rule. Delamain and Oughtred both used this type, which has the advantage of requiring only one logarithmic line for calculation, where the sliding type of rule requires two lines. It is also possible with this type to use not just a circumferential line, but to make the line spiral, and thus greatly increase the length of the line (and accuracy) for a rule of given radius.

The rule is shown in the two positions necessary to perform the multiplication of two and three to give six. The first step is to set the arm A on the index and arm B on two. Then, arm A is rotated to three, the angle beta remaining fixed by the friction between the two arms and the arm B will indicate the answer.

News of the College

H. G. Booker Joins EE Staff

Professor Henry G. Booker, world famous authority on propagation of radio waves, has been appointed to professorship in the College of Electrical Engineering to take effect this semester. Professor Booker has performed scientific investigations in such far flung corners of the earth as India, Australia, and England, and before the war was a research associate in the department of terrestial magnetism of the Carnegie Institute in Washington, D.C. During the war he did important telecommunications work for the British Ministry of Aircraft Production, where he was in charge of the theoretical group on Radio Wave Propagation. Since the war Professor Booker has been University lecturer in mathematics in the Cavendish Laboratory at Cambridge's Christ's College as well as being on the staff of the College.

Professor Booker was also scientific advisor to the British Broadcasting Company, and an editor of the radio series of the Clarendon Press, Oxford. He is a graduate of Cambridge University where he received both the BS and the PhD. The thirty-eight year old British scientist is widely known in Europe and America for his work in theoretical electromagnetism and radio propagation in the troposphere and ionosphere. He is the author of several important and generally accepted theories concerning radio wave propagation, both for microwaves and short-waves.

He evolved the theory of radio propagation in the ionosphere, taking into account the effect of stratification and the earth's magnetic field in shaping the wave path. In the Mode-theory of radio propagation in the troposphere, he developed an explanation for the transmission of ultra-short-waves beyond the horizon. Dr. Booker has conducted considerable radio meteorological research, and has been honored for this work by the British Institution of Electrical Engineers.

Prof. Booker

It is tentatively expected that Professor Booker will teach graduate courses in Radio Science, and wave propagation. He will also act in an advisory capacity on research in the College of Electrical Engineering.

Form Engineering Council

A student council whose purpose will be to represent the Engineering student body is presently being formed on campus. This organization will discuss and take appropriate action on matters of common interest to student engineers. A constitutional committee is drawing up the first draft of the new organization's constitution. Neal FitzSimons C.E., and President of the student branch of the American Society of Civil Engineers, together with representatives of the other engineering schools, are cooperating in forming this organization.

During the present spring semester it is expected that elections will be held in the various engineering colleges on campus to elect permanent representatives to the council. Among the tentative aims of this group is to back the establishment of a student-faculty lounge in Sibley Hall, and the eventual organization of an engineer's day on the campus, which would give students of the other colleges an opportunity to get an inside look at the College of Engineering.

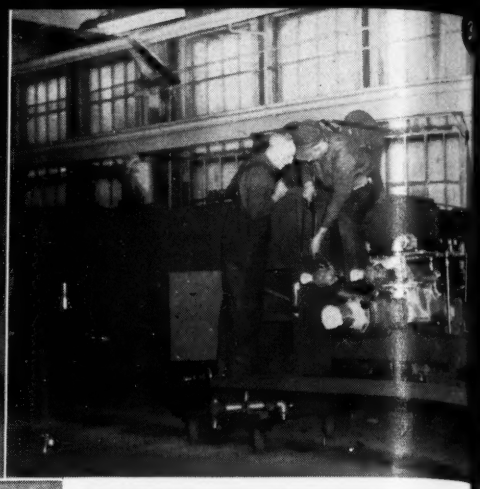
Pi Tau Sigma Initiates

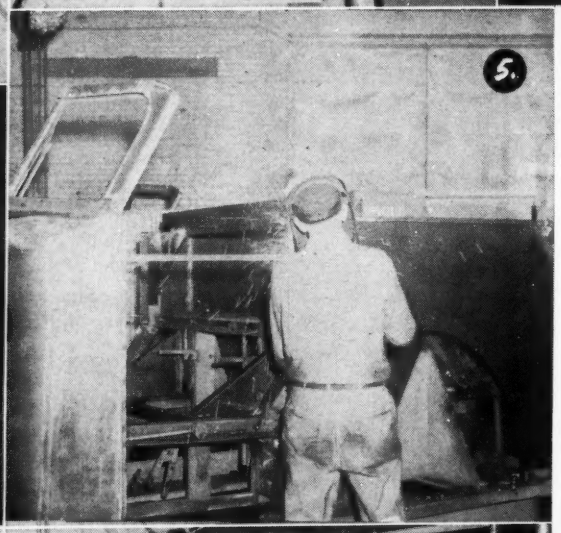
During the month of December, Pi Tau Sigma was busily engaged in the election of new members. After several meetings concerning election policies for the newly organized society, a smoker for prospective memers was held at Beta Theta Pi on December 9th. Elections took place immediately after the smoker.

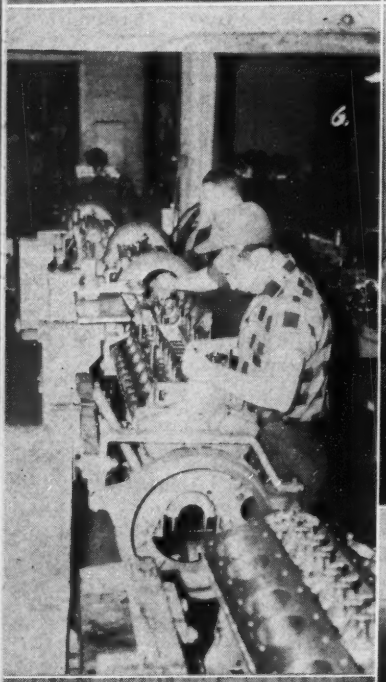
The following mechanical engineers were elected to membership:

Otto E. Adams, Jr.
J. Perry Barger
Leo R. Bell
Frank L. Bradley, Jr.
Ralph I. Coryell, Jr.
Robert P. Crease
Walter S. Crone
Harry W. Daniell
Richard G. Elmendorf
John N. Eustis
Harold W. Ferris
Warren H. Heimer
Jack H. Hobson
David W. Kennedy
Robert G. House
Howard Kaltbaum
Thomas J. Kelly
Frank W. Kinsman
John W. Laibe
Charles A. Peek, Jr.
Robert H. Staplin
Joseph R. Stein
William Stevenson
James L. Strong, Jr.
Charles E. Swanson
Francis W. Walker
Richard L. Wanner
David Westerman
Nathan A. Weston
Daniel K. Roberts
Spencer M. Robinson

At the same election meeting on December 9th, Dean Emeritus Dexter Kimball was elected to honorary membership. The initiation banquet was held January 7 at the Club Claret in Ithaca.







Following the Assembly Line

Fig. 1. At the start of the tour, Engineer Sam Wolcott, shown standing on a steel truck frame, informally lectured to the class group, in preparation for what they were about to see in the course of the tour. In the foreground can be seen a truck rear axle assembly.

Fig. 2. A six wheel tractor-drawn ladder truck is shown taking form on one of their progressive assembly lines. By the free use of welded construction throughout the frame work, greater rigidity is secured.

Fig. 3. The centrifugal water pump being worked on above is completely built by American-La-France. This pump uses two impellors, one of which has double suction and one single suction. For high volume, low and intermediate pressure work, the two impellers are placed in parallel, while for lower volume, high pressure delivery, the impellers are placed in series, with the double suction impeller acting as the low pressure stage. The change from one condition to the other is accomplished by swinging a handle on the control board, which actuates plug valves in the water passages.

Fig. 4. In the heat treating shop, a stainless steel pump shaft is quenched in an oil bath.

Fig. 5. A welder, in the sheet metal shop is shown fabricating a cab assembly after clamping the component parts in a jig. A subsequent grinding operation will remove the weld beads and their surface roughness.

Fig. 6. A lack of commercially available engines with the required combination of high horsepower, high dependability, and reasonable cost, and the requirement peculiar to the fire truck business that replacement

Photo-Tour Through A
Fire Fighting Equipment Plant

By THEODORE FEDKEW, M.E. '49 and
CHARLES A. PEEK, JR., M.E. '49

Photographs by Ted Fedkew

Everyone has seen a fire truck, but thow many people are aware of the engineering problems that are confronted in producing an adequate and acceptable piece of mobile fire fighting apparatus? The class in Automotive Engineering at Cornell has a better than average idea of these problems after their visit to the plant of American-LaFrance-Foamite Corporation, located in Elmira, New York. This company manufactures fire fighting equipment from the ground up, producing most of the required parts in their own plant.

Over a period of years the demand for greater power in fire trucks has steadily increased. As a result their engines have become more and more powerful, wheel base longer and longer, visibility and maneuverability poorer and poorer, and their overall manufacturing costs have risen beyond a profitable level. To meet these demands and still overcome their resulting difficulties, American-LaFrance departed from the conventional design and introduced a revolutionary, new model. It was designed after an extensive survey throughout the country to determine the likes and dislikes of fire chiefs as based on existing equipment. The product which was finally evolved incorporated an engine mounted behind the cab. This shortened the wheel base by permitting the front axle to be moved farther back on the frame. It furthermore moved the driver from a point well back along the frame where visibility was strongly curtailed, to a point ahead of the front axle giving optimum visibility.

The following Cornellians have taken part in the development of some of the apparatus of the American-LaFrance-Foamite Corporation:

The late Professor C. E. O'Rourke, Professor of Structural Engineering at Cornell University, was consulting engineer on the structural designing of the aerial ladders.

W. M. Price, M.E. '26 Vice-President and assistant to the President.
S. K. Wolcott, Jr., M.E. '36, M.M.E. '45 Motor and Pump Engineer.
N. H. Smith, A.E. '39 Engineering Department Members.
R. C. Reese, M.E. '47 Engineering Department Member.

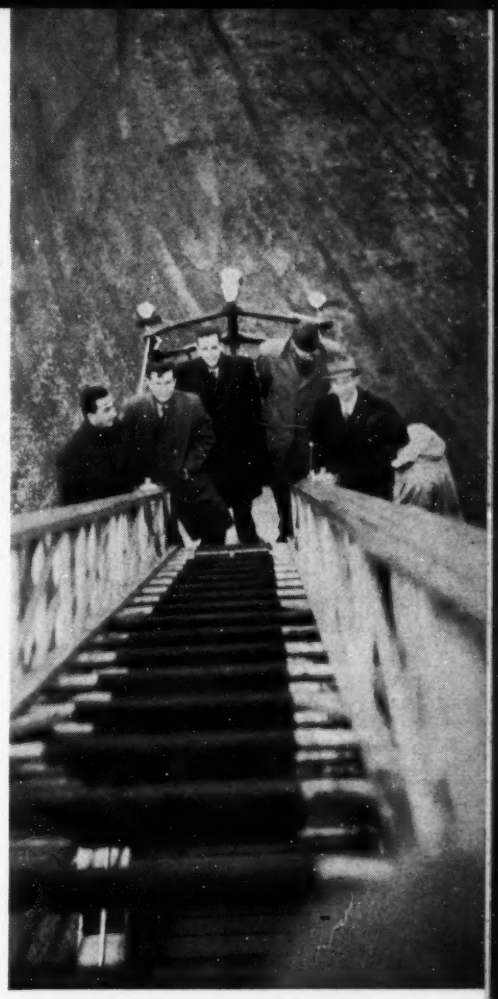


Fig. 11

Fig. 10

parts be available for periods up to thirty years or better, forced American-LaFrance to design and build their own engines. At left is illustrated their assembly line for their smaller V-12 engine which is capable of developing 204 horsepower.

Fig. 7. Upon completion, every engine is given a performance test before it is mounted in a truck. Here a 204 horsepower engine is being tested on a Froude Hydraulic Dynamometer.

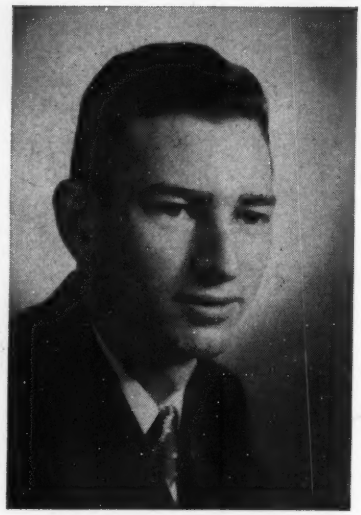
Fig. 8. American-LaFrance engineers were present at a luncheon to answer any questions that may have developed in the minds of the students during the morning. Shown above is chief engineer A. G. Sheppard addressing the group. Seated to his left is Professor L. L. Otto, and to his immediate right is R. Smith, an assistant to Messrs. Sheppard and Wolcott.

Fig. 9. After a ride on one of their trucks to their experimental station and proving ground, the students were given a demonstration of the operation of the 100 foot aerial ladder. The large pumper shown is demonstrating a pumping capacity test. Each pumper is completely and thoroughly tested under all capacities and pressures. A ramp at one side of the tank allows suction lifts as high as sixteen feet to be used.

Fig. 10. The hydraulic drive for the aerial ladder permits the ladder to be raised to any position. Uniquely incorporated into its design is an automatic calculator which indicates the safe load the ladder can carry at any angle and any degree of extension, eliminating guess work on the part of the operator.

Fig. 11. A bird's eye view from one of American-LaFrance's big selling points, their 100 foot aerial ladder. Another view of the same ladder appears as the frontispiece (page 4).

PROMINENT



Nate

Nathan Ehrlich, EE

Back in June, 1941, six months before Pearl Harbor, when Nathan Ehrlich graduated from Roosevelt High School in Washington, D.C., he never dreamed that one day he would be graduating from Cornell.

Like many a high school graduate he was uncertain as to exactly what he wanted to make his lifetime career. A citizen of the nation's capital, Nate entered the College of Business and Public Administration at the nearby University of Maryland in September, 1941, planning to follow a career in accounting. As he had always enjoyed math and science in high school, Nate chose math and physics electives whenever he could. At Maryland he was a member of the Collegiate Chamber of Commerce and was elected to the freshman honorary society, Phi Eta Sigma.

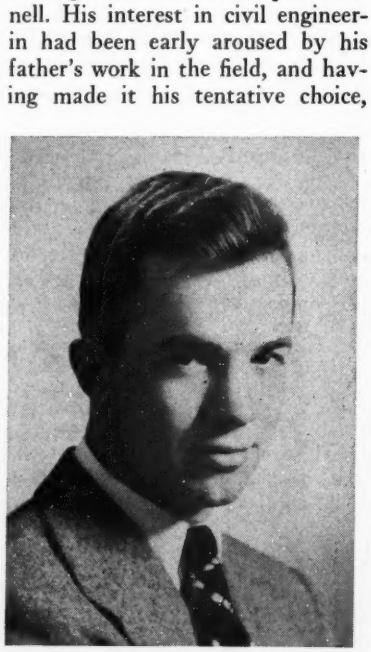
In March, 1943, his application to the Army Air Forces meteorological training program was accepted. He entered the army and was sent to New York University for technical training in June, 1944 and received a commission in the Air Forces. New York University awarded him the degree of Bachelor of Science in Meteorology. As a weather officer, Nate analyzed weather information, issued weather forecasts, briefed aircrews before departure on flights, and advised operation officers on the flying conditions to be expected. He served

(*Concluded on page* 40)

John D. Ten Hagen, CE

Among those who graduate from Cornell this June to take their place in the engineering world is John D. Ten Hagen. He is another of those, all to few, students who are able to combine scholastic excellence with active participation in the many other aspects of campus life.

From Warsaw High School in Warsaw, New York, John, or as he is popularly known, "Dirck" enrolled in the school of Civil Engineering in July, 1943. It is not surprising to find him choosing Cornell, for he had the double incentive of being the son of Cornellian, Henry Ten Hagen, '13, and of receiving a State Scholarship to Cornell. His interest in civil engineerin had been early aroused by his father's work in the field, and having made it his tentative choice,



Dirck

he now finds himself well satisfied with its promise as a career.

In June, 1944 his training was interrupted by two years in the Navy as a radio technician, serving in the occupation forces in Japan. Returning to Cornell in September, 1946, he resumed the rush back and forth to classes to the musical accompaniment of creaking stairs in Lincoln. But civil engineering was by no means all that held his attention. Starting as a compet two years ago, he worked up to his present job as Varsity Basketball Manager, an extracurricular of no mean extent, considering the numerous comings and goings of the Big Red quintet. Music, too, claims his interest, although he would claim his piano playing to be more of a diversion than an activity.

One need only to read the list of honoraries to which he belongs to learn his status as a student: Quill and Dagger, Tau Beta Pi, and Chi Epsilon. In addition he is a member of Phi Delta Theta and Pyramid.

Although he has made no choice of a job as yet, he finds highway construction of especial interest. Enthused by a course in the determination of topography from aerial photos, he is hoping to find work which will allow him to apply this specialty to highway construction. The concensus of opinion is that with his vigor and training, success only awaits opportunity.

Thomas H. Latimer, AEME

Tom, perhaps better known to his friends as "T.H." hails from the midwest. Born in Hamilton, Ohio, Tom graduated from Hamilton High in 1942.

Coming to Cornell in the fall of '42, Tom enrolled in the ME school and was registered in the enlisted reserve corps. He completed two terms and was called into active service. He went to Fort Sill in Oklahoma for his basic and followed with six months at Oklahoma A.&M. College in the A.S.T.P. before that program folded. Camp Maxie, Texas, was the next stop. He joined the 99th infantry, and finally wound up in the divisional artillery.

Tom shipped out to England in September of '44 and proceeded on to Belgium, just in time to get caught in the Battle of the Bulge. Coming through unscathed, he ended up in Munich as part of the occupational army. Although he was

ENGINEERS

sent to England for a few months of school before going home, Tom was back in Hamilton in January of '46. March brought Cornell into his life once again.

An active fencer in high school, Tom has been captain of the Cornell fencing squad for the past two seasons. He was president of the Fencing Club last year.

Tom has been a prominent participant in other campus organizations. He has capably served as secretary for the Interfraternity Council; vice president of Quill and Dagger, senior men's honorary; and freshman camp counsellor this past year. He has achieved and maintained a high scholastic standing. Tau Beta Pi, Kappa Tau Chi, and Pi Tau Sigma are scholastic honoraries to which he belongs. He is president of his fraternity, Phi Sigma Kappa, this term and has done a very fine job.

Tom has been enrolled in the advanced ROTC program the past two years. Last summer, he received his commission as second lieutenant in the reserve corps of the Army.

Tom graduates this month and hopes to go into industrial or production engineering. Following the advice of the proverb, if you want a job well done, give it to a busy man. Tom would be your man.

Tom

Jack

Jacques L. Zakin, ChemE

Attracted by a New York State Scholarship and a Cornell Tuition Scholarship, it wasn't hard to persuade Jacques Zakin that Cornell was THE school. So, one day in July, 1943, found "Jack", as he is known to all, knocking on the doors of Olin Hall, as a prospective chemical engineer.

Jack's career began in Far Rockaway, one of the more important suburbs of the "Big Town", N.Y.C. His pre-collegiate days were spent in Far Rockaway High School, where he participated in a number of diversified activities—from science and math clubs to Pan-American fiestas.

A few weeks after graduation, Jack entered Cornell, and one of his first constructive acts was to sign up as a "compet" for the CORNELL ENGINEER; his perseverance was rewarded by election to the Editorial Board in his first term. An ability to get things done is indicated by the list of extra-curricular activities which Jack began compiling in his first year—Pershing Rifles and the now defunct Freshman Lunch Club, in addition to being named to the Dean's list in his second term.

But Jack's stellar accomplish-

(*Concluded on page* 40)

The Editor's COLUMN

Engineering Student Council

For some time it has been felt that there was a need for an organization composed of representatives of the various engineering schools at Cornell. This fall such an organization was formed by members of the student branches of the professional societies, with the purpose of promoting school and college spirit and bringing about closer contact between the engineering schools.

Membership in this organization, named the Cornell Engineering Student Council, is composed of two representatives from the ASCE, ASME, AIEE, AIChE, and CSEP (Cornell Society of Engineering Physics). Two officers of each society and one representative of Tau Beta Pi also sit as ex-officio members.

There is much that such a council can do to improve the spirit of the engineering college. Among its proposed projects are the sponsoring of an Engineer's Day to be held in the spring. Before the war such a day was held each year and it is to be hoped that the council will be successful in its efforts to reinaugurate it. In addition the council is seeking membership in the Student Council. Such membership would be very desirable since, at the present time, the engineers must be represented through other organizations. Another desirable aim of the council is to serve as a liaison group between undergraduates and the Cornell Society of Engineers.

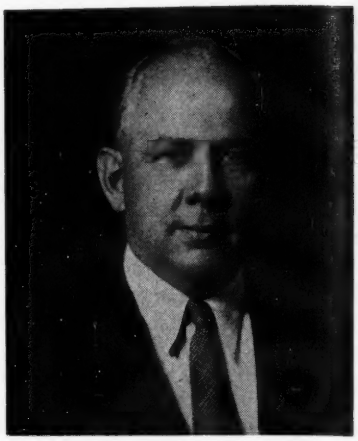
The CORNELL ENGINEER wishes the newly formed Cornell Engineering Student Council the best of luck and offers its help whenever it may be needed.

Farewell--

With this issue five members of the CORNELL ENGINEER staff sever their connections with the magazine by graduation. It has been a pleasant and a worthwhile association, and to the remaining members of the editorial and business boards they wish their best. *C.P.I.*

Cornell Society of Engineers

107 EAST 48TH STREET 1948-1949 NEW YORK 17, N. Y.



Creed W. Fulton, M.E. '09

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Message

Our efforts to marshall all our manpower and organize it effectively to achieve the objectives we have established for this year, seem to be bearing fruit.

Saturday and Sunday, December 12th and 13th, were spent in Ithaca, conferring with Dean Hollister, directors Burrows, Christensen, King, Rhodes, Sears, and Smith and with representatives of various undergraduate engineering groups. These discussions centered on ways and means of bringing our Society closer to the faculty and to the undergraduates, and making it more useful to the University and to all our engineering graduates.

We are particularly anxious to have the senior class in the College of Engineering understand better our major aims and objectives, our organization and the manner in which it functions, and where and how they can actively participate and enjoy the benefits of membership as alumni. This year we want to stop the leak which in the past has permitted a large percentage of engineers, who are graduating, to leave Cornell without becoming members of our Society.

We feel that our Society can be a source of real benefit and pleasure to all our engineering alumni, as well as an effective tool for supporting the University's engineering program. I am glad to be able to report to you evidences of great interest in, and enthusiasm for, our new program, both by the faculty and numerous representatives of the various undergraduate engineering groups who participated in these December conferences. Some interesting undergraduate developments were reported under way, which when consummated will lend unity and strength to undergraduate engineering activities, and permit effective integration of their interests and activities with those of our Society.

On January 14th, I had the privilege and pleasure of addressing the senior class in Engineering, at Ithaca. I presented to them at that time the program we have developed, and the advantages of membership, in a manner that I hope, will persuade them to enlist, en bloc, as active members.

We need to sell these younger members in large numbers, on the many advantages of membership and of active participation in Society affairs, through the years ahead. I believe we will be successful in doing so, with this year's senior class, but that will still leave us with the problem of selling our society to some 13,000 Cornell engineering graduates who are not members.

That is the part of this job on which we must rely on you who are members for help.

You know by now what we are trying to do, the value of our program to the University and to all our engineering graduates. Will you not enlist yourself as a recruiting officer in this cause?

All we have asked you to do is to secure at least one new member for our Society. All around you are prospects. You know who and where they are.

I urge you to give this program for further enhancement of Cornell's great reputation, and further widening and strengthening of the acceptance of Cornell engineers everywhere, your personal and aggressive support.

We expect to develop an organized campaign shortly, but just think what it would mean if each and every one of you 3,000 alumni readers of the CORNELL ENGINEER would voluntarily go out and recruit just one new member each.

That is something every one of us could do. How about making that your job for February, 1949?

CREED FULTON

Class of February, 1949

SCHOOL OF CHEMICAL ENGINEERING

Photograph includes both February and June graduates

1st Row: Smith, J. C. (Professor), Leins, E. K., Dana, J. S., Griffith, G. E., Burgess, W. H., Ray, J., Rowland, D. G., Pearson, R. W., Rhodes, F. H. (Director), Wiegandt, H. F. (Professor), Hecht, J. L., Mason, C. W. (Professor), Burton, M. S. (Professor).

2nd Row: Bilhorn, J. M., Weaver, W. B., Loeser, W. R., Roberson, D. C., Younghouse, E. C., Barber, W. P., Gilbert, S. R., Stein, R., Mayer, J. F., Kyle, P. E. (Professor), Winding, C. C. (Professor), Gregg, J. L. (Professor).

3rd Row: Shonnard, C. W., Reinhold, C., Milana, R. E., Louis, R. A., Carter, B. P. (Miss), Soffen, M. C., Stranz, B. B., Logan, J. A., Zakin, J. L.

4th Row: Lane, M. K., Manogue, W. H., Sutherland, D. C., Shaner, R. L., Corning, H. F., Jewett, J. E., Gelbin, D. E., Harriott, P., Christenson, J. S.

5th & 6th Rows: Pattist, E. J., Weber, J. W., Wagner, W. V., Fairchild, R. L., Mengel, J. W., Cope, C. S., Williams, E. J., Canfield, K. S., Farber, J. C., Brenholts, W. L., deProsse, E. P., Schneider, E. A., Roland, J. J., Nelson, E. E., Sylvester, H. S., Hand, H. A., Morrison, R. K., Koch, W. M., Scofield, H. M., Wallingford, H. P.

SCHOOL OF CIVIL ENGINEERING

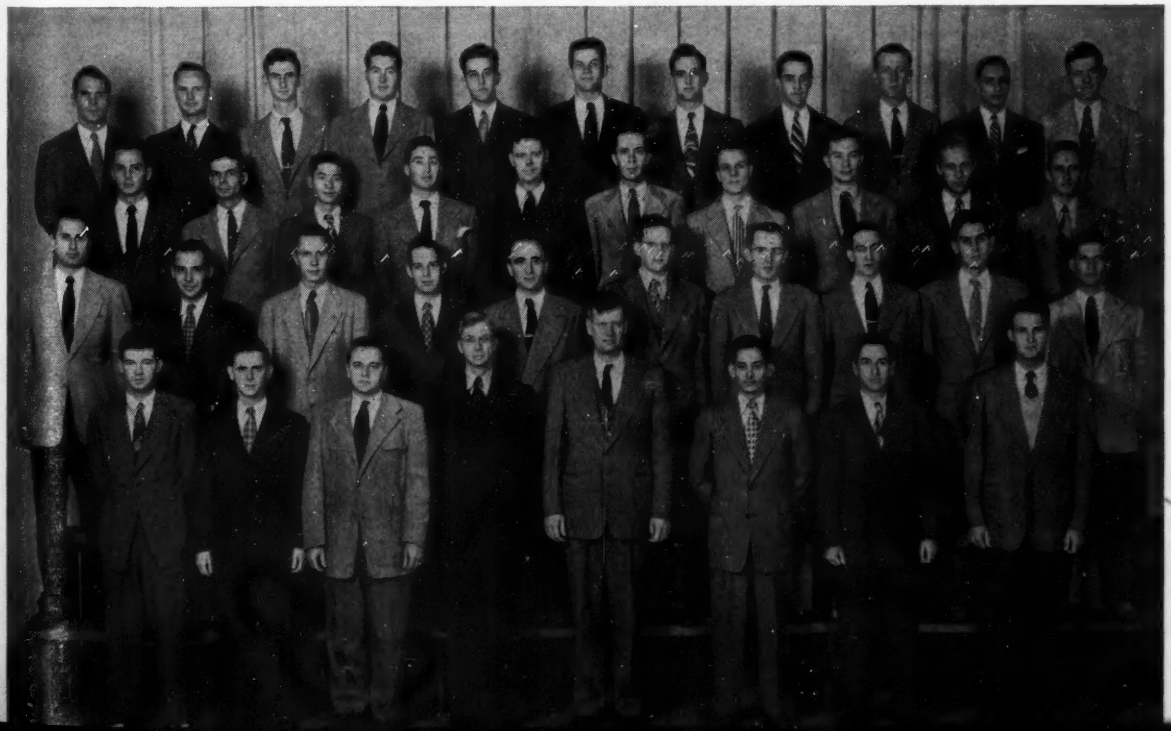
1st Row: Conable, L. L., Jr., Goodman, W., Buchanan, D. A., Jenkins, H. T. (Prof.), Christensen, N. A. (Director), Vazquez, J. R., Schwartz, M. D., Moore, V. B., Jr.

2nd Row: Kaplan, G. L., Payeras, H. J., Rasmussen, L. B., Michaels, C. C., Pesce, G. V., Taylor, M., Plumb, V. A., Hickey, W. J., Burtch, C. E., Sundheim, P. E.

3rd Row: Dawson, J. W., Buck, J. M., Chann, I. K., Lipian, R., Kanenbley, W. A., Mendenhall, W., Roberts, J. E., Baumann, F. L., Peters, R. E., Irwin, C. P.

4th Row: Schrauth, A. J., Cownie, D. L. Jr., Chapman, R. S., Treleaven, A. R., Caruthers, D. E., Rogers, J. B., Engelbert, R. W., Mattie, R. S., Murphy, H. C., Jr., Bender, K., Gilbert, J. J., Jr.

(*Senior class photographs of electrical and mechanical engineers apeared in the January* CORNELL ENGINEER.)



Alumni News

Albert B. Cudebac, C.E. '08, is vice-president of Hydropress Co., Inc., heavy hydraulic presses and rolling mills, New York City.

The 1948 John M. Diven Award for highest service to the American Water Works Association went to **Clinton Decker, C.E. '09,** sanitary engineer with Tennessee Coal, Iron & Railroad Co., Brown Marx Building, Birmingham, Ala. Decker was chairman of the committee which revised the Association's Manual of Water Quality and Treatment and it was this service which brought him the award. Illness prevented him from going to the convention in Atlantic City, N. J., last May, but the award was made in absentia and presented to him in Birmingham with ceremonies later. Decker is a member of the American Society of Civil Engineers and a past president of the Birmingham Engineers Club.

Robert W. Hendee, M.E. '17, president of Colorado Interstate Gas Co., Colorado Springs, Colo., was elected president of the American Gas Association, October 5, at the annual convention and exhibition of the Association in Atlantic City, N. J. Hendee is a trustee of Colorado College, a director of Colorado Springs National Bank, and president of the Colorado Springs YMCA. During the war, he was a member of the Petroleum Industry War Council, serving as chairman of the natural gas and natural gasoline committee for District 4.

Robert W. Hendee

Charles S. Rich, M.E. '26 formerly secretary of the AIEE technical program committee, has been named editor of the Institute's official publications, **Electrical Engineering** and **Transactions.** He was appointed engineer-in-charge of the underground systems bureau of the Westchester Lighting Co., Mount Vernon, N. Y., following his graduation, and remained with that company until 1928, when he became district engineer for the southern district of the U.S. Leather Co., Ridgeway. Rich joined the AIEE staff in February, 1930, in his recent capacity as secretary to both the technical program committee and the committee on the award of Insitute prizes. His work included the preparation of technical programs for AIEE meetings and processing of manuscripts for review.

William R. MacDonald, Jr., E.E. '32, has resigned as associate editor of **Electrical Engineering.** He joined the AIEE editorial staff in 1934 and was named an assistant editor in 1938. Following service as a major with the Signal Corps from 1941 to 1944, MacDonald returned to AIEE publications as acting editor.

William P. Stein, M.E. '44, is sales manager of the Bar-Ray Products, Inc. maufacturers of X-ray accessories in Brooklyn, New York.

Donald R. Pierce, B.Arch. '47, has been granted the $1200 Milton Medary Fellowship of the American Institute of Architects for advanced study in Architecture. He is studying at the University. The fellowship is awarded only to men who hold the School Medal of the AIA. Pierce was awarded the medal in 1947.

Carl F. Ostergren, M.E. '21, died last December 25th after a brief illness, at his Long Island home. Mr. Ostergren was president of the Cornell Society of Engineers during the 1947-48 school year.

Carl F. Ostergren

After graduating from Sibley in 1921, Carl Ostergren worked as an engineer for the New York Telephone Company until 1945, culminating his career of steady progress with his appointment, in 1945, as assistant vice president of the American Telephone and Telegraph Company. Since 1946, he was patent license manager of the Western Electric Company.

Besides his active participation in the Cornell Society of Engineers, Mr. Ostergren was a member of the Cornell Clubs of New York and Nassau County, Phi Kappa Pi, and Delta Sigma Rho. He was 47 years old.

We've proved it!

Problem: To hold down costs, and speed the extension of telephone service.

Solution: High-strength wire whose use allows the span between poles to be increased from 150 feet to more than 300. One pole now does the work of two.

The problem, of course, is a continuing one for telephone people. High-strength wire with required electrical qualities is only one of many things they have developed to help solve the problem in these days of high construction costs.

In total, their developments are the reason why telephone service here is the best in the world—the reason why it remains low in cost.

BELL TELEPHONE SYSTEM

Circular Slide-Rule

(*Continued from page* 14)

easy his circular rule is to operate, and tells that it is "fit for use . . . as well on Horse back as on Foot."

We know that he was a friend of William Oughtred for some time. He traded books with Oughtred, and often received help from him in mathematics. There was little friction between the two men. They frequently took walks about London discussing topics related to mathematics.

Versions of the Conversation

Delamain's version of a particular conversation as paraphrased from one of his books follows: We spoke about the excellent inventions and helps to computors that in these days were produced, and in particular logarithms, of which I was very much taken. I commended the ingenuity of Mr. Gunter in his logarithmic lines. Then (says Delamain) Oughtred replied, "What will you say to an invention that I have which works truer than Mr. Gunter's ruler?" I asked him in what form it was and he said "Archlike." At which I immediately answered that I had the like myself and we no longer spoke about the subject.

On the other hand, the Reverend Oughtred says that the conversation went this way: I told him about an instrument I was having made of logarithms projected into circles, which being less than one foot diameter would perform as much as one of Master Gunter's rulers of six feet. Delamain hesitated, and suspiciously said to me, "Such an invention have I," and we let the matter drop.

Such a difference in the two stories would be trivial except that a few weeks after the conversation Delamain sent to Oughtred a model of his rule. If what Delamain says is true, then he independently conceived of the circular rule, for all the information he got from the Reverend during the walk was that Oughtred had some kind of archlike rule. But if William Oughtred's story is correct, then Delamain got from him enough information to construct the rule, and then, having immediately seen how to construct it, pretended that he already had done so. This, Oughtred claimed, Delamain did in order to immediately make a working model and present it to the world as his.

The only thing we can say definitely about the conversation in view of the two versions is that they must have talked about the circular rule, and each let the other know that they had a circular rule. It is entirely possible, and probable, that both men independently conceived a similar circular rule.

After the transfer of information that November day in 1630 there was still no enmity between the two men. Delamain continued to visit Oughtred, and lent him books —remember that the statements quoted above were made after the men had begun to quarrel.

Disputed Book Published

At the end of 1630, two months after the disputed walk, Delamain published the book which was later to subject to attack, The *Grammelogia* or *Mathematical Ring*. The book described in detail two forms of circular rules. It was the first time any publication appeared concerning the construction of a cir-

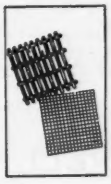
(*Continued on page* 26)

The better the woodsman the better the axe!

. . . and experience buys the best industrial equipment, too

THE MOST SKILLED CHOPPER invariably owns the fastest axe . . . And engineers who buy industrial equipment on the strength of experience, get topmost efficiency and economy. Performance records tell why Roebling products have enjoyed more than a century of confidence.

ELECTRICAL WIRE—CABLE—MAGNET WIRE. There's a high quality Roebling Electrical Wire and Cable (65 standard types) for every sort of transmission, distribution and service circuit . . . Roevar Magnet Wire is unsurpassed for high-speed winding operations.



WOVEN WIRE FABRIC. Economical Industrial Screens by Roebling range from the most finely woven Filter Cloths to the largest Aggregate types. Roeflat Screen, a radically new design, has 75% more wearing surface, up to 90% more wear.

ROUND — FLAT — SHAPED WIRE. You cut down reject costs and speed up production with Roebling high carbon wire...every inch is like every other inch . . . same gauge and grain structure . . . same strength, hardness and finish. . . . and it's available *now!*

WIRE ROPE. Roebling rope is one of the *most widely used* products in industry today . . . and Roebling Preformed "Blue Center" Steel Wire Rope is the last word in long-time performance and genuine service economy. Only Roebling makes "Blue Center" wire rope steel.

Whatever career you are studying for, when you get on the job you will find some type of Roebling product serving there, dependably and at low cost. John A. Roebling's Sons Co., Trenton 2, N. J.

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Circular Slide-Rule

(*Continued from page* 24)

cular slide rule depending on the principle of one scale sliding past another. His rule was almost as complete as present day rules, with the customary scales for number operations corresponding to our C and D scales, complete trig scales, and other scales for use in navigation, astronomy and surveying. He also described a different type of circular slide rule which used pivoted pointers to perform the operations. The pointers were the forerunner of our hairline indicators. The mode of operation of this type of rule is shown in the diagram accompanying this article.

Delamain also gave instructions for the use of the rules, which made the first printed instructions for the use of a slide rule. Concerning the invention of the rule, in the preface to this first edition, Delamain said that he originally had the idea in February 1629, dated his preface January 1630 and received the following patent from King Charles I:

"Whereas Richard Delamain, Teacher of Mathematicks, hath presented unto Us an Instrument called Grammelogia, or The Mathematical Ring, together with a Booke so intituled, expressing the use thereof, being his owne Invention; we of our Gracious and Princely favour have granted unto the said Richard Delamain and his Assignes, Privilege, License, and Authority, for the sole Making, Printing and Selling of the said Instrument and Booke: straightly forbidding any other to Make, Imprint, or Sell, or cause to be Made, or Imprinted, or Sold, the said Instrument or Booke within any our Dominions, during the space of ten yeares next ensuing the date hereof, upon paine of Our high displeasure. Given under our hand and Signet at our Palace of Westminster, the fourth day of January, in the sixthe yeare of our Raigne (Jan. 4, 1631)."

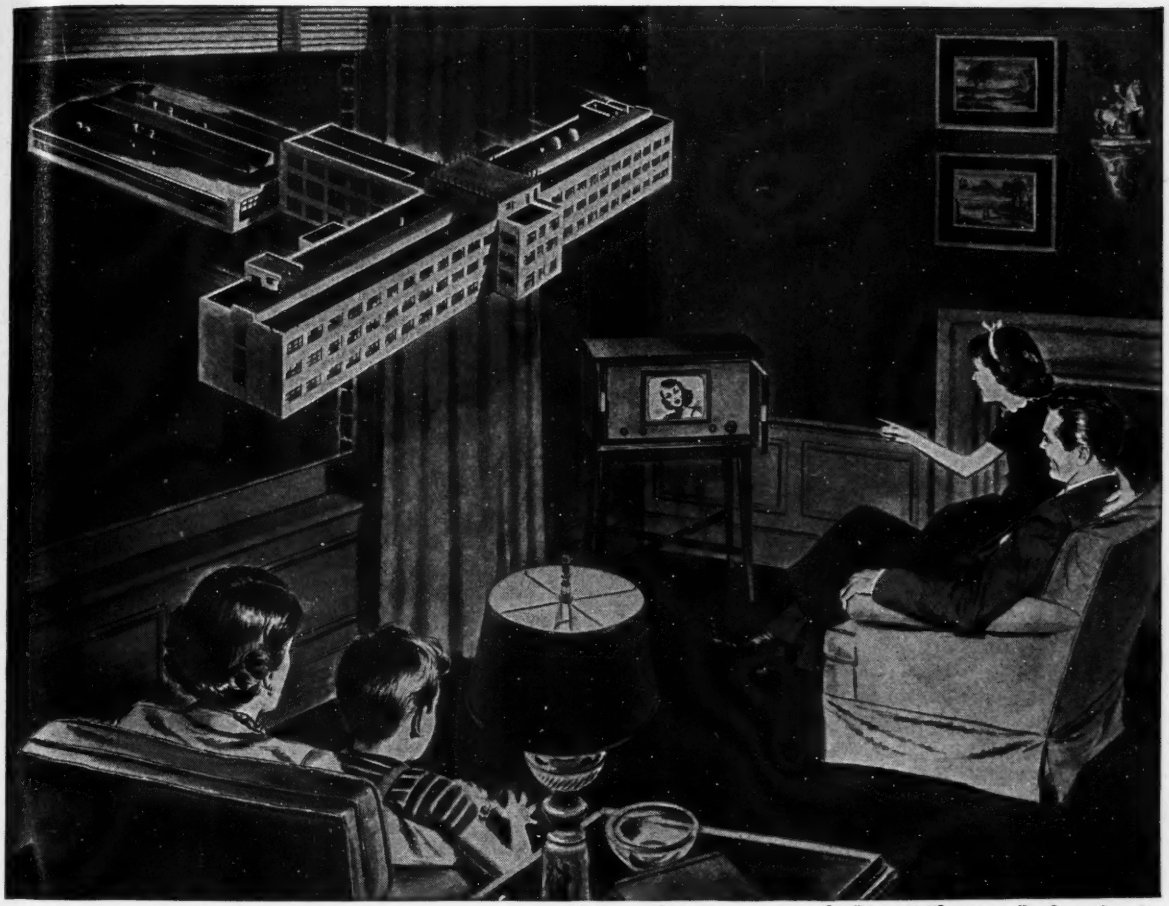
It is interesting to note how our present concept of patents and the rights of inventors compares with "Our high displeasure."

Book Fulfilled Its Purpose

Typographically the book was very poor, with pages numbered out of order, and some pages unnumbered. Occasionally the same page appeared several times in one book, each time with a different page number. Despite this, the purpose of publication was fulfilled, and knowledge of the circular rule spread through England.

After the publication of the first edition of the *Grammelogia*, Oughtred still did not show any rancor towards Delamain. If he did feel that Delamain had stolen his idea, he certainly did not seem to care. Delamain continued to visit Oughtred and about a year later while

(*Continued on page* 28)



Into your living room comes the "Age of Electronics"—through radio and television research achievements of RCA Laboratories.

Research *comes to life in your Living Room*

Turn on your radio, tune in a television set—as simply as that you have completed the final step in a long chain of research and invention...

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A few examples of RCA leadership: all-electronic television, the all-electronic radio receiver, and the Victrola radio-phonograph. The iconoscope, television's electronic "eye," was developed by Dr. V. K. Zworykin—now of RCA Laboratories. Super-sensitive Image Orthicon television cameras and kinescope "picture tubes" for receiving sets and radio relays are RCA *firsts*.

Actually, these are just a few of the *hundreds* of examples of RCA leadership in radio and electronic research and engineering "know-how"... that give *value beyond price* in any product or service of RCA or RCA Victor.

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Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
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Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RADIO CORPORATION of AMERICA

World Leader in Radio—First in Television

Circular Slide-Rule

(*Continued from page 26*)

working on a new mathematical instrument was sending pages of the book to Oughtred for proof-reading. This instrument, too, Oughtred was to later claim that Delamain had stolen from him.

Assume Both Invented Rule

If we make the assumption, reasonable under the conditions, that the two men independently invented the circular rule, we may make some reconstructions which will agree with the later history of the controversy. On hearing from Oughtred that he too had conceived of a circular rule, Delamain must have gone to work immediately so as to publish as soon as possible. His welfare depended on his ability to maintain a reputation as a skillful designer and mathmetician. He relied heavily on his friendship with the King, a friendship which was bolstered by gifts of many instruments of his own design.

Oughtred's students, however, did not like the idea of Richard Delamain getting credit for what they believed *their* teacher had invented. Chief among the agitators was one William Forster who had for some time been translating Oughtred's scientific works from Latin into English. Forster continually pleaded with his teacher for permission to publish the translations of the works, in particular the material describing Oughtred's circular slide rules. Forster was convinced at this time that Delamain had stolen the idea from his teacher. Finally, two years after the publication of the *Grammelogia,* Forster published Oughtred's *Circles of Proportion.*

This book described Oughtred's form of the circular rule, and Oughtred claimed 1621 as the date of invention. It was the preface of this book, written by William Forster, that started the controversy between Delamain and Oughtred. In this preface Forster made attacks on Delamain, although not mentioning him by name. He stated that some other person, whom he disdained naming, had stolen the invention from Oughtred.

Even after this unpleasant item appeared in print, Delamain and Oughtred were friends, Oughtred borrowing from Delamain a book on trigonometry. Nonetheless, in order to meet this attack, Delamain released a new edition of the *Grammelogia.* There were a few changes in the technical part of the book, but there was an addition. Delamain added another preface, in which he too stated that some person he would not mention had stolen *his* invention.

There was now no doubt as to who each of these men was talking about, and Oughtred retaliated with another edition of his book in which he added an *Epistle* and proceded to mention Delamain by name and spared no epithets. It was in this *Epistle* that Oughtred gave the sour opinions which were quoted in the introduction to this article. The fight was now in the open, and both men claimed to have prior invention in letters to each other, in letters to friends and in repeated editions of their respective books. Oughtred claimed that the other had stolen the idea during that fateful walk up Fishstreet hill. Delamain claimed that Oughtred had copied his idea from the *Grammelogia.*

Trenchant Attacks By Oughtred

Ougthred's attacks were by far the most vituperative. He was working under a disadvantage, for Delamain had published first. When Delamain wrote against Oughtred he had merely to point out that Oughtred could have very easily copied from his book. Oughtred had witnesses to attest to his earlier date of invention, however, and he relied on this. Oughtred accused Delamain of base motives, of associating with him so that he could spy, and of copying from Oughtred's unpublished work. He even stooped to questioning Delamain's entire moral character. Unfortunately most of the evidence Oughtred used in these accusations was hearsay, and it is unlikely that it was true. Oughtred's students apparently were great tale-carriers and built up in him a resentment by their continual harping that need never have been aroused.

The argument had little effect on contemporaries, although it lasted for several years. Delamain continued in good standing as a teacher

(*Concluded on page 36*)

DU PONT Digest
For Students of Science and Engineering

The story of A CHEMICAL ACHIEVEMENT

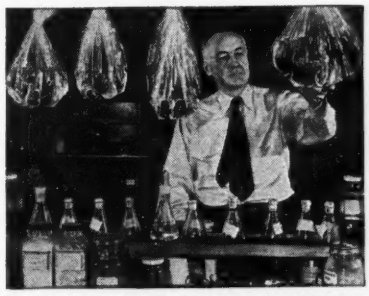
How Du Pont scientists found a way to Moistureproof Cellophane

There's no secret to Du Pont's successful system for making chemical discoveries. It is simply research through teamwork.

As each new problem in research arises, it is tackled by men and women whose training and skill qualify them to master it. Backed by ample funds and facilities, they are continuously extending the field of scientific knowledge.

Take the case of moistureproof Cellophane. Plain, transparent Cellophane was strong, clear and protective. As a packaging material it had eye appeal. Its uses were limited, however. Perishable foods wrapped in this cellulose film were protected from contamination and were good to look at, but they did not retain their freshness. They either lost or absorbed moisture, depending on the nature of the food and atmospheric conditions.

That was a challenge to Du Pont research people. They set out to find materials that would moistureproof Cellophane without materially affecting its thinness or transparency. After developing a basic test to measure moistureproofness, they tried various procedures—adding ingredients to Cellophane dope before casting, impregnating sheets in baths and coating the film.



Dr. Hale Charch, *Ph.D., Ohio State '23, reenacts discovery of moistureproof Cellophane film. Bag at far right held water for weeks; other control bags showed evaporation.*

Coating showed the most promise. Had you been a member of the research team on this job, you might have helped mix and test several hundred different coating formulae over a 10 months' period. With successful coatings in sight, a small pilot operation was set up. Then—to make sure the new Cellophane was right—doughnuts, cookies and cakes were wrapped in it and sent to market. Finally, engineers were called on to design machinery for full-scale operation.

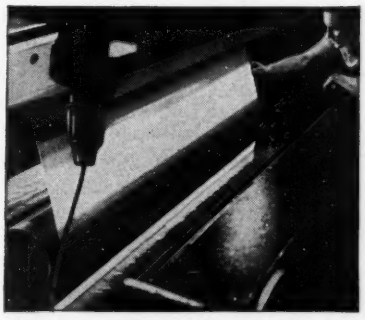
Now everything from chewing gum to porterhouse steaks is being sold in moistureproof Cellophane. Another scientific achievement is helping change the food packaging and food buying habits of America!

Using your training at Du Pont

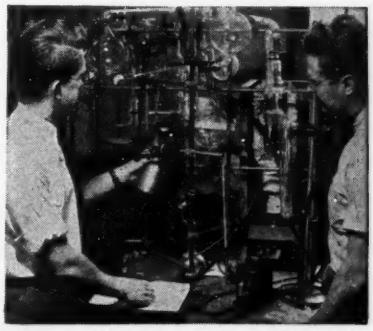
Diverse problems call for diversified talents. At any one time, there are hundreds of interesting projects under way in the Du Pont laboratories. You may be trained in chemistry, engineering or physics. You may have studied in the fields of botany, entomology, parisitology, pharmacology or plant pathology. In fact, almost all the sciences are put to use at Du Pont.

Working as a member of a small team, the individual is afforded every opportunity to show his talent and capabilities.

Cellophane has become *the nation's symbol for modern packaging. Since 1927, continuing research has developed over fifty different types.*



Cellophane is made *by extruding viscose through a slit into an acid bath where it coagulates into sheets. Moistureproofing follows.*



Organic Chemist M. L. Ward, *Ph.D., Illinois '42, and Physical Chemist P. E. Rouse, Jr., Ph.D., Illinois '41, conducting research on the permeability of thin membranes, including Cellophane.*

This is a booklet you shouldn't miss

Before deciding on your first job, send for your free copy of "The Du Pont Company and the College Graduate." Describes opportunities for men and women with many types of training. Explains how individual ability is recognized and rewarded under the group system of operation. Address: 2518 Nemours Building, Wilmington 98, Delaware.

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Sand Research Project

(*Continued from page* 12)

found in foundry work. Another objective of the Project, growing out of the first objective, is the development of some routine tests which could be used for control work in foundries.

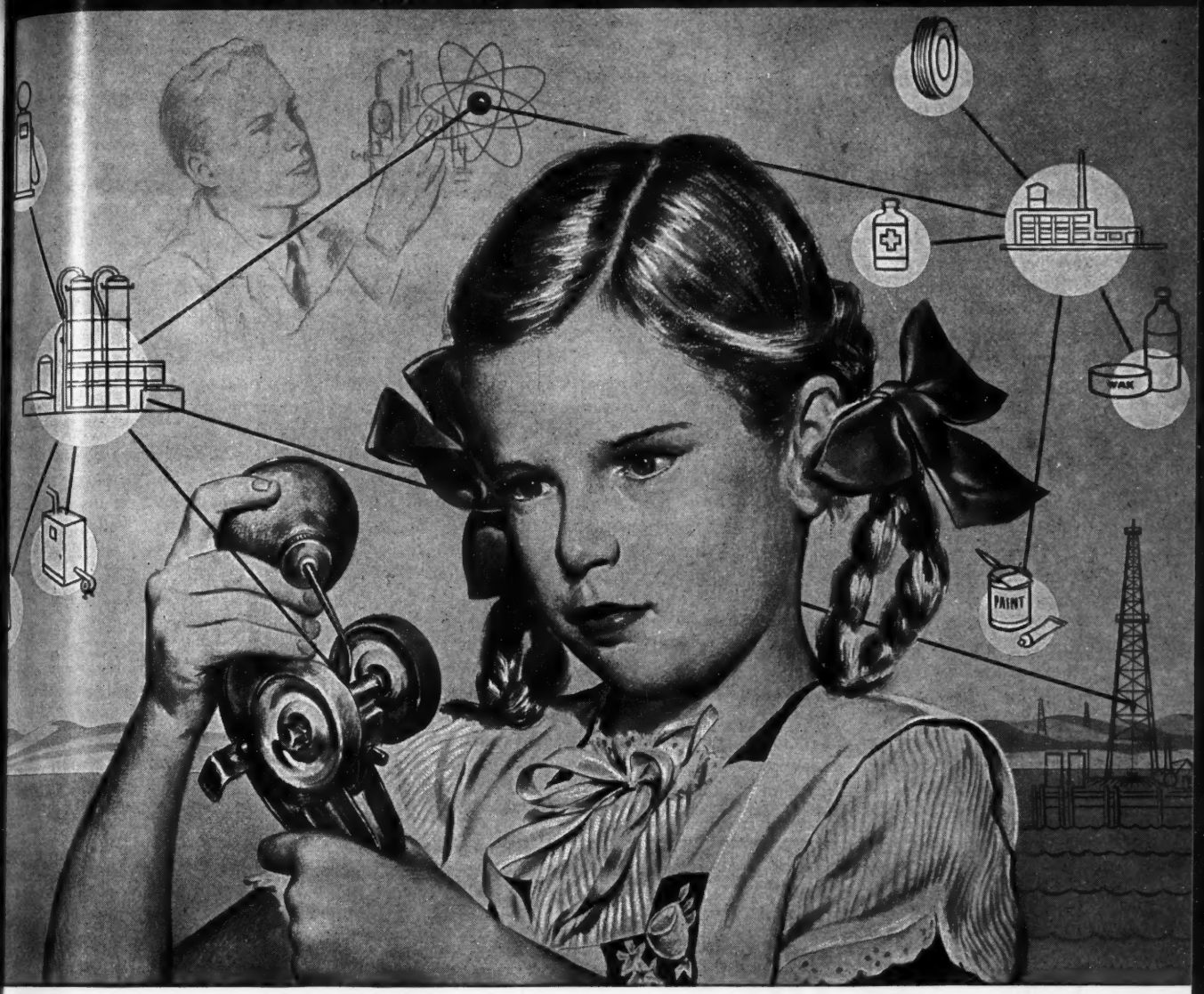
More or less putting the cart before the horse, one of the first pieces of equipment developed at Cornell was a dilatometer which consists of a compressive strength testing machine with a furnace built around the test section so that tests may be conducted on heated specimens. The first dilatometer had a gas-fired furnace, but the need for higher temperatures brought about the use of electrical heating. The present model has a hollow, cylindrical, silicon carbide resistance heating element and is quite satisfactory up to furnace temperatures of 2500°F.

The test specimens used are made by carefully placing a weighed quantity of the moist sand mixture in a cylindrical mold, 1⅛ inches in diameter, and ramming the sand into place to give a sample 2 inches long. The rammer used is designed to stimulate the ramming a sand receives in a mold; it allows a weight to drop a specified distance onto the specimen, thus compacting the sand into a fairly strong shape.

The dilatometer has a small piston pump to actuate the loading system. The specimen is supported in the center of the furnace on a refractory rod, and the loading piston drives the specimen, resting on the lower supporting refractory rod, upwards against another refractory rod. The hydraulic pressure applied to the loading system is indicated by a pressure gauge. An interesting feature of the loading system is a by-pass line which allows the loading piston to be moved either quite rapidly by hand or at a slow, controlled

(*Concluded on page* 38)

"—The seeds of godlike power are in us still"—MATTHEW ARNOLD



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UNDER THE WATERS just off the Gulf Coast alone . . . lie vast new oil fields that may almost double America's oil reserves.

This rich discovery is just one more phase of the better-than-ever job the oil industry is now doing to meet our soaring demands. And back of that job are today's superior skills, advanced engineering, and *better materials.*

Such hard metals as tungsten carbide, used in drills, help make it possible to cut more than three miles into the earth. Essential valves, pumps, and even fractionating towers made of *carbon* are virtually 100% proof against highly corrosive acids.

Such better materials as stainless steel defy heat, pressure and corrosion in refinery operations. With the new oxy-acetylene pressure welding, pipelines can be more swiftly linked into single strong units that extend for hundreds of miles.

Better chemicals, also! Solvents that purify our oil . . . chemicals that draw offensive elements from our gasoline and provide us with anti-knock compounds. All these are helping bring us better medicines, waxes, cosmetics, paints . . . to name only a handful of today's hundreds of superior petroleum products.

The people of Union Carbide produce these and many other materials that help supply us with more and better petroleum products. They also provide hundreds of other materials to help science and industry maintain American leadership . . . in meeting the needs of mankind.

FREE: *You are invited to send for the new illustrated booklet, "Products and Processes," which shows how science and industry use UCC's Alloys, Chemicals, Carbons, Gases and Plastics.*

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Voice of the Worker

(*Continued from page 7*)

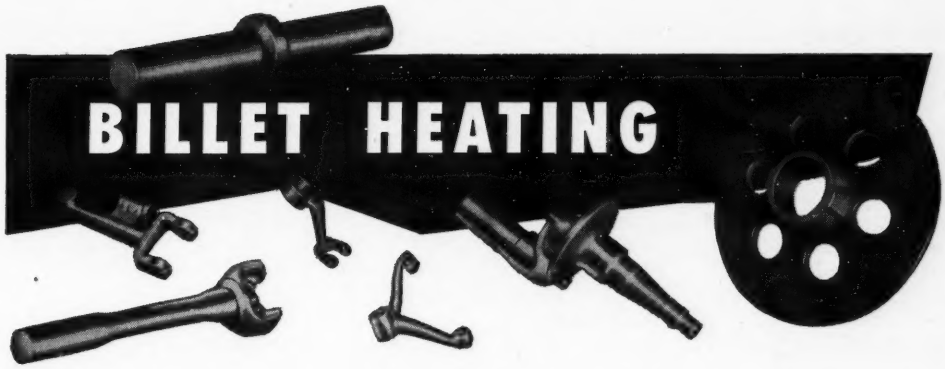
The number of workers now organized into unions has become so large that the union grievance procedure is a very important channel of communication. The worker takes his complaint to the union steward, who first checks the facts to be sure that the complaint is a legitimate grievance. If it is, the steward, either with or without the worker, goes to the foreman for a settlement. If the foreman either refuses to satisfy the request, or is not empowered by management to make decisions on grievances of that particular type, the steward will appeal the grievance to the next level. This usually consists of a meeting of in-plant union representatives and company representatives of superintendent level. If the grievance is not settled here, there may be several additional steps in the procedure before the dispute is submitted for arbitration, depending on the union contract in the particular company. At the last step before arbitration the union is usually represented by an international representative and management by company officials. Thus the complaint registered by worker Jim Brown with the steward may run the complete course, although most grievances are settled at the lower levels.

There are three comments which should be made about this system from a communication standpoint. First, while the steward does some screening of complaints at the start, he is the workers' representative and in borderline cases carries the ball for the worker. Contrast this to the line of authority channel where there is little a worker can do if the foreman is not interested in his complaint. Secondly, the grievance procedure is set up to short circuit the line of authority so that complaints may be taken up immediately at the level of management which has the authority to make a decision upon the issue. This provides for more rapid settlement, and prevents sifting or blocking, which may occur at intermediate levels in the straight line of authority channel. Finally, it should be observed that the whole procedure is set up to service complaints or grievances. Very little is done about transmission of constructive suggestions or ideas which will promote the efficiency of the organization. As was pointed out at the beginning of this article, the expression of ideas on the part of workers and their recognition and use by management constitute a basic need both for the worker and for management. It is in this respect that the union procedure is lacking as an adequate means of communication to top management.

The Lincoln Electric Advisory Board

Possibly one of the most advanced and enlightened means of worker communication to top management is represented by the Advisory Board at the Lincoln Electric Company. The board is composed of elected employee representatives, the personnel director, the superintendent of each of the two plants, and the general manager. Its purpose is to provide an organization for settling employee grievances, and for acting upon

(*Continued on page 34*)



Drop Forge Division Operations

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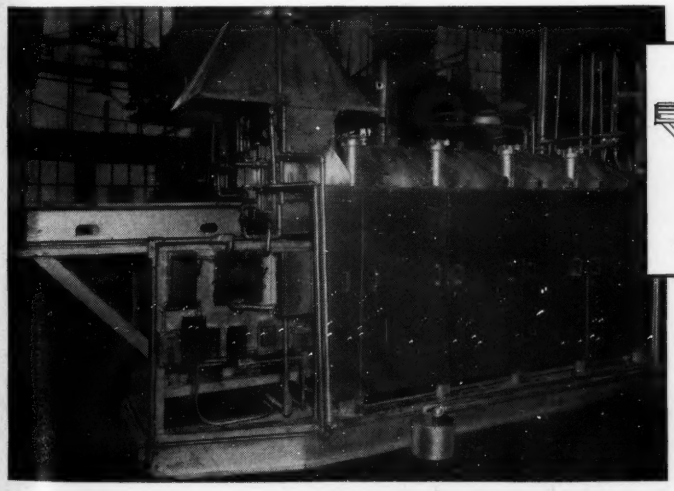
Drop Forge Division engineers and metallurgists, working with the furnace manufacturers, devised a simple Gas-fired, continuous-cycle billet furnace with the following characteristics and capabilities:

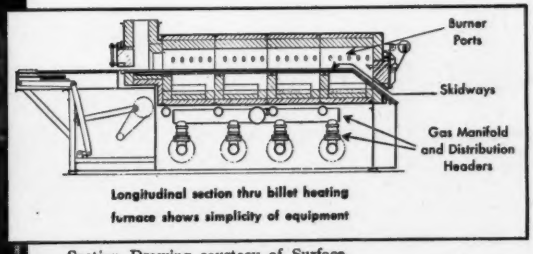
- **Billet Temperatures—2,200°-2,300°F**
- **Billet Heating Time—4 minutes normal (can be regulated as required in production schedules)**
- **Billet Discharge Rate—440 per hour, on 4-minute cycle**
- **Piece Dimensions (Average)—1"-2.5" thickness or diameter for rounds, squares, or flats up to 10" in length**
- **Furnace Heat-up Time—2,500°F in 15 minutes after initial lighting**

Quite as important as the productive capacity of the furnace are results of high-speed billet heating with GAS—

- **Uniform temperature of billets improves workability in forge**
- **Reduced scale minimizes abrasion in dies**
- **Flexibility for different sizes and shapes without costly equipment changes**
- **Economy of operation, of fuel costs, and of equipment investment**

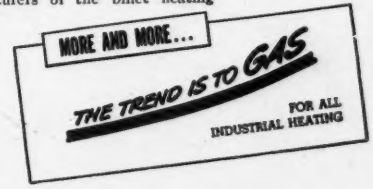
This application of modern Gas Equipment in an important production-line process is just one of the contributions made by GAS to industrial progress. There are many other heat-processing operations such as annealing, normalizing, stress-relieving, case-hardening, in which the productive flames of GAS have established records for productioneering. They're worth investigating.





Longitudinal section thru billet heating furnace shows simplicity of equipment

Section Drawing courtesy of Surface Combustion Corporation, Toledo, Ohio, manufacturers of the billet heating furnace.



AMERICAN GAS ASSOCIATION

420 LEXINGTON AVENUE NEW YORK 17, N. Y.

Voice of the Worker

(*Continued from page* 32)

constructive suggestions for improving working conditions, safety, or employee welfare. It meets regularly every other week.

Personal attendance at two advisory board meetings in addition to a study of the minutes for meetings of the last five years is the basis for the following observations.

Grievances Presented

The board meetings are started by the general manager asking each representative if he has a suggestion or grievance from any of his constituents. In this way it is assured that every idea or legitimate complaint made by any worker in the plant will be heard by the president, and action taken immediately. Thus many small but important matters are solved before anyone gets steamed up about them. The remainder of the hour is spent discussing company policy, new products, and business conditions in general.

Practically all requests made by advisory board representatives for minor items of convenience, safety, or better working conditions are granted immediately by management. In fact, prompt action is a keynote of these meetings.

Requests which affect company policy are often not granted. For example, a request that the bonus be paid every three months instead of annually was turned down. In this connection, it should be noted that the president has veto power on any board decisions which are contrary to company policy. As president of the company, Mr. Lincoln sets the policy, so that the board can not take action which he deems unwise. However, the attitude of management and workers on this board is one of 100 percent cooperation. All ideas presented are thoroughly discussed. If the president feels that a proposal will not be of long range benefit to the company, he explains his reasons carefully so that each of the board members can see the complete picture. When a vote is taken, the majority of the board invariably votes down the proposal. If a majority of the board voted in favor of the proposal, further discussion would be held and some compromise reached which was satisfactory to a majority of the board. In the history of the board the veto has never been employed by the president.

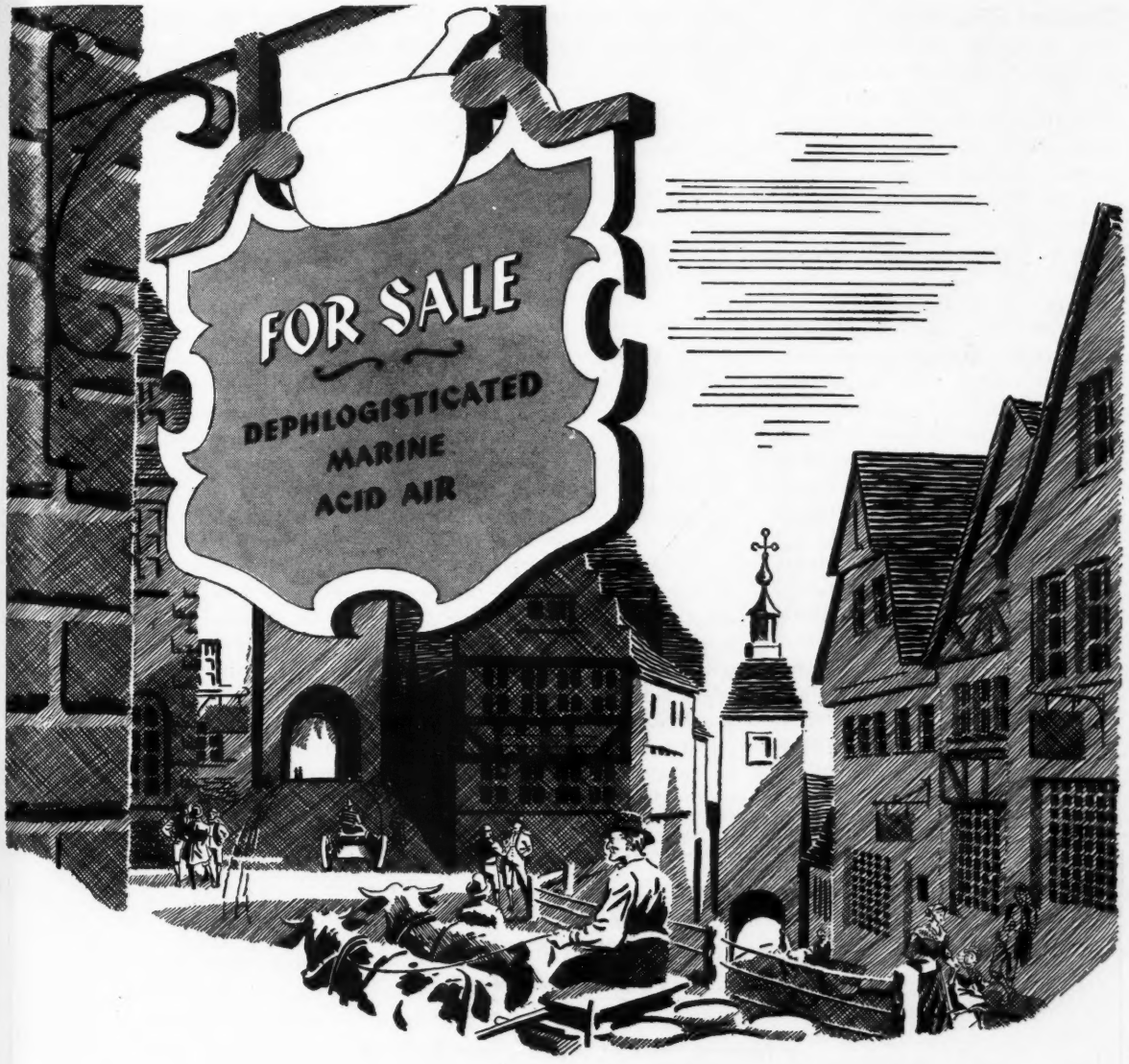
Following the meeting each representative reports back informally to the workers of his department, and the minutes of the meeting are posted on bulletin boards throughout the shop, where they are read by all workers.

The success of the system depends upon the character and human qualities of the president. This may be considered one weakness of the system.

Management Changes Attitude

There is a changing attitude of management towards worker expression. This has been forced, to a considerable degree, by the rise of unionism in this country. In spite of the injustices occasioned by union power without proper leadership, the union movement has opened the eyes of management to the necessity of considering the worker as a human being as well

(*Concluded on page* 36)



Had the discoverer of CHLORINE, Karl Wilhelm Scheele, envisioned only a fragment of its importance to mankind, such a sign might well have hung above his modest eighteenth century Swedish pharmacy. But "Dephlogisticated Marine Acid Air" remained a laboratory curiosity for years, its identity as Chlorine and its remarkable potentials unknown.

Today, the vast influence of Chlorine on civilization is ever-widening. Employed originally only for its bleaching and germicidal properties, more recently Chlorine has also become invaluable to synthetic organic chemistry . . . to the expanding manufacture of such products as plastics, high-test gasoline, delicate dyes, medicines, synthetic rubbers, special solvents and fine chemicals.

Columbia, with its affiliate, Southern Alkali Corporation, is the nation's leading merchant producer of Liquid Chlorine. Pittsburgh Plate Glass Company, Columbia Chemical Division, Fifth at Bellefield, Pittsburgh 13, Pennsylvania.

COLUMBIA CHEMICALS

CHICAGO · BOSTON · NEW YORK · CINCINNATI · MINNEAPOLIS · ST. LOUIS · PITTSBURGH · CLEVELAND · PHILADELPHIA · CHARLOTTE · SAN FRANCISCO

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PITTSBURGH PLATE GLASS COMPANY

Circular Slide-Rule

(*Continued from page* 28)

of mathematics and military engineer, and Oughtred was as respected as ever. There were no great sums to be made from the sale of circular slide rules, and the motivation for the argument was mostly pride. The net result, in the judgment of history, has been to throw doubt on the honesty of Delamain, although not on his ingenuity, and to question the judgment of Oughtred in matters not mathematical. The true villians of the piece were, I believe, Oughtred's students who were not content to let well enough alone. In their desire to have *their* teacher get the credit, which meant little to him, they were willing to risk his good name in scandal.

There is often doubt concerning the priority of important inventions. The combination of cultural and technical environment that stimulates a man to conceive a new and original object is usually widespread. Many men will be living in the same atmosphere and attempting, with the same education, to solve the same problem. Time and time again, two or more men have independently come to the same conclusion. Out of all the controversies that have taken place between prominent men of science who independently came to the same conclusions, one thing is clear: There is little to be gained from such a controversy. Another notable case of such a dispute was that between Newton and Liebnitz, in which the eager partisans also played their catalytic part. In that case as well as this one, the result was reduced prestige for both men.

As for the question of who invented the circular slide rule, we cannot say that it was one man. All we can say, is that, in the light of our present meager factual information, that Oughtred and Delamain probably independently developed, at about the same time, the circular slide rule. The important thing is that as a result of Oughtred's independent invention of the rectilinear rule, and the work of both Oughtred and Delamain in conceiving and developing the circular rule, we have today our excellent aids to computation.

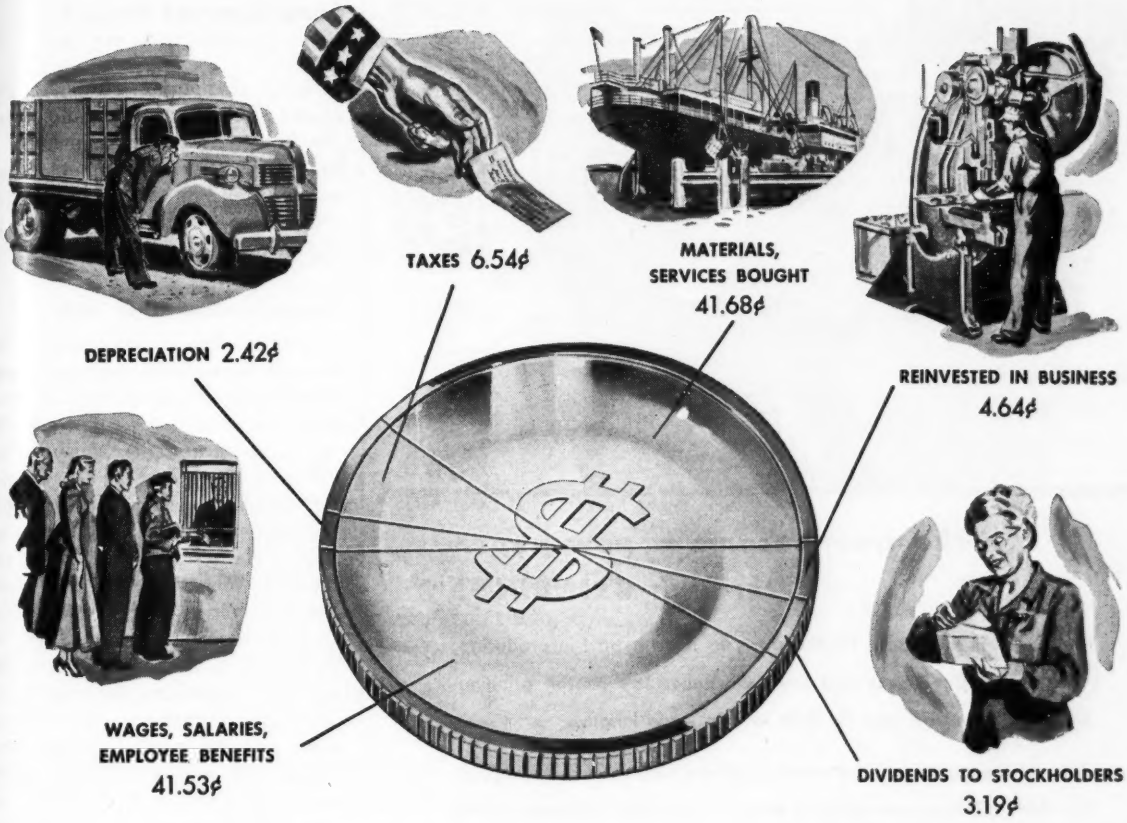
Voice of the Worker

(*Continued from page* 34)

as a device for production. Management has found that there was a great deal it could learn from the worker.

Management has also found that while we have made tremendous gains in production due to technological advances, the key to still greater production lies in the field of human relations. The psychologists are accumulating data to show the relationship between worker expression and worker satisfaction, and between satisfaction and production. This is the ground work for future strides.

The trend in this country is towards increased worker participation. This must be supported by an increased educational level of workers if there is to be a real meeting of the minds. It also means that our capitalistic system will have to find within its framework the means of satisfying the needs of worker expression and participation, or else socialism will force its way into this country as it has done in England.



HOW TO DIVIDE UP A DOLLAR

. . . the American Way

It may interest you to know the mistaken notions most folks have about the profits of American companies.

They tell interviewers that they *think* such companies are entitled to make 12 to 15 cents on every dollar of income, as a fair return. Yet, they add, it's their guess that manufacturers *actually do* make about 25 cents!

The facts are that in normal years American companies average about *nine cents* profit per income dollar.

Take Aluminum Company of America in 1947, for example. Out of each dollar received last year by Alcoa and its subsidiaries, the net profit amounted to *less than eight cents*. We show above where the rest of that dollar went. Nearly half of it in wages, salaries, and employee benefits, to Alcoans. Almost another half for materials and services we bought. Over six and a half cents for taxes.

The dollars-and-cents story of Aluminum Company of America represents the kind of facts you'll get from any typical American enterprise. Facts that show a fair return for a good product.

By dividing up a dollar, the American way, Alcoa has provided secure employment for 46,000 aluminum workers and has helped America to gain world leadership in aluminum production and research.

ALCOA

Aluminum Company of America

Sand Research Project

(*Continued from page* 30)

rate by the pump. The data obtained in this instrument show that the hot compressive strength of a sand is a function not only of its composition but also of the furnace temperature and soaking time in the furnace.

Expansion-Contraction Tests

Another line of investigation at Cornell is into the expansion and contraction characteristics of sand mixtures. In this case, not only the test temperature and exposure time influence the behavior of the sand, but also the method of conducting the test has its influence. For instance, the tests may be conducted by using "shock" heating, in which the specimen is suddenly subjected to a high furnace temperature, or by slowly heating the furnace and specimen together; the results, including the maximum total expansion, will differ. Also, it has been found that any load applied to the specimen while hot, including its own weight, affects the observed expansion and contraction characteristics. The system at present in use at Cornell attempts to minimize the effects of external loads by using a long, horizontal specimen and measuring its length optically.

Globar Type Electric Furnace

The furnace used for the expansion studies is also heated electrically, using Globar, silicon carbide resistance elements. Nine of these resistors are used, in three banks of three elements each, and the furnace can be operated up to temperatures of 2700°F. The controls on this furnace include a rather unique capacitance-control system, using condensers in series with the heating elements to control the voltage impressed across the elements, while the smaller dilatometer employs a step-down transformer with a number of different voltage offtakes.

Although a great deal of valuable information has already been obtained from the Sand Research Project, the end is not yet in sight, and work at Cornell will probably continue for some time to come.

Prominent Engineers

Nathan Ehrlich

(*Continued from page* 18)

with various outfits but his principal assignment was with the Twentieth Ferrying Group of the Air Transport Command.

Although he enjoyed weather forecasting, Nate didn't think there was enough of a future in the profession. When he was discharged as a First Lieutenant after three and a half years of service he decided to study electrical engineering. His military service had often brought him into contact with various electronic equipment and this seemed to be another field he would enjoy working in. He applied to Cornell and entered the School of Electrical Engineering in February, 1947. In his two years at Cornell Nate has been quite active; he is a member of the Editorial Board of the CORNELL ENGINEER, a studio engineer for WVBR, a member of the Hillel Council, Sigma Alpha Mu, and Kadimah. He has also been elected to membership in Eta Kappa Nu.

This past summer Nate was employed in the Antenna Research Section of the Naval Research Laboratory in Washington, D.C., where he gained valuable practical experience in communications engineering. He graduates this month and plans to do design and development work in the ultra-high frequency field.

Jaques Zakin

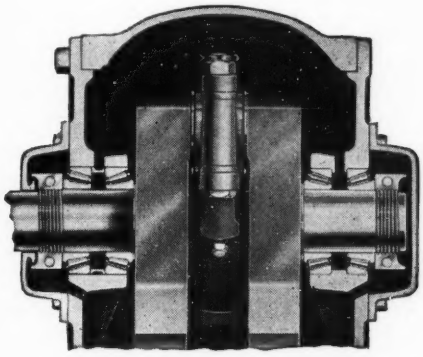
(*Continued from page* 19)

ments were interrupted by the United States Navy, which called him into training in March, 1945. After completing the Navy's Radio Technician Training Program, he was stationed aboard the destroyer U.S.S. Sarsfield. The end of hostilities brought an honorable discharge in August, 1946, and the transition from "tin cans" and transformers to beer cans and books.

Having taken chemical engineering for many years, Jack is now approaching the end of the long climb to a B.Chem.E. His interest and ability in this field are indicated by his winning a McMullen War Scholarship and an Undergraduate Scholarship. He is a member of Alpha Phi Omega—National Honorary Service Fraternity, American Insitute of Chemical Engineers, Cornell Rhythm Club, and he has been elected secretary of the Chemical Engineering Student Council. In addition, he has devoted much of his time to the ENGINEER, serving as publicity and compet manager for the past year. Also, his avid interest in sports has not waned; for, as a "sparkplug" of the McGraws, he helped obtain the All-Sports Trophy which this independent team received last season.

Now, ranking fourth in his class, he is looking toward graduation this month with confidence. His plans for the future are not definite, but he has been considering entering some phase of engineering development or design. Whatever his goal, we believe Jack will get the most out of everything he does.

Another page for **YOUR BEARING NOTEBOOK**



SH-H-H! A quieting thought for compressors

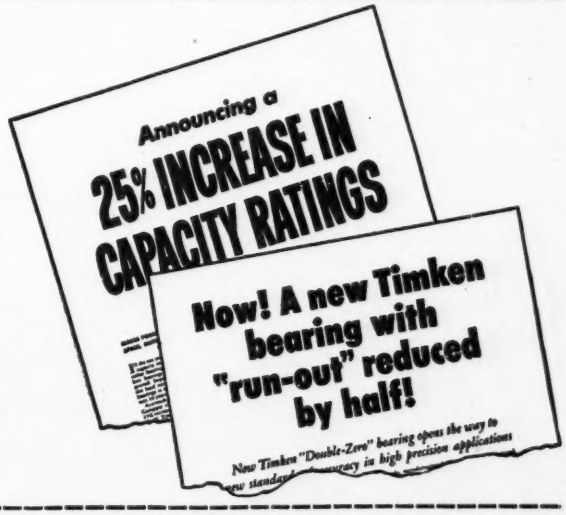
Engineers design quiet operation into heavy duty compressors by mounting the crankshafts on Timken® tapered roller bearings.

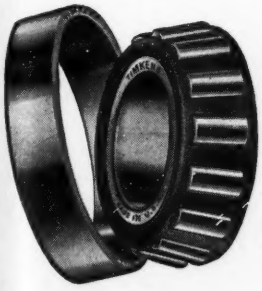
Timken bearings take the tough radial and thrust loads in any combination. They hold the crankshaft in rigid alignment, prevent deflection and end-play. Wear is minimized, precision increased. And long, quiet, trouble-free operation is assured.

What's new!

Two great developments have been announced recently by The Timken Roller Bearing Company. First, the capacity ratings of all Timken bearings have been increased 25%, enabling engineers to use smaller bearings, with savings in bearing cost, material cost and weight.

Second, the new Timken "Double-Zero" bearing —twice as accurate as any previously made—opens the way to new, higher standards of precision. These are the two latest examples of the Timken Company's well-known leadership in bearing manufacture.





TIMKEN
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TAPERED ROLLER BEARINGS

Want to learn more about bearings?

Some of the important engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⊕ AND THRUST ⊖ LOADS OR ANY COMBINATION ⊕⊖

STRESS and STRAIN...

Any similarity between these jokes and those in other college magazines is purely intentional.

* * *

Chem. E.: "Drink broke up my home."

E.E.: "Couldn't you help yourself?"

Chem. E.: "Nope! The damned still blew up."

* * *

Freshman: "I don't know."
Sophomore: "I'm not prepared."
Junior: "I can't remember."
Senior: "I don't believe I can add anything to what has already been said."

Sorority Rushing . . .

The conversation had turned to the subject of fraternal organizations. This went on until one of the coeds who hadn't been interested to start with became bored with the whole thing. Suppressing a yawn, she remarked:

"Well, I don't know anything about the Masons, but I do think their fruit jars are very nice."

Overheard in the Straight cafeteria:

Cook: "Say, boss, the garbage man is waiting outside."

Manager: "Okay, tell him to leave three cans today."

* * *

At a ship's concert one night a magician was entertaining the passengers. The magician first made a rabbit disappear. Then he made a girl disappear. The parrot looked on in awe and exclaimed, "Amazing!" Suddenly there was an explosion and the ship went under. The magician was floating along on a piece of wreckage when the parrot flew up and said, "That's a pretty good trick. No kidding, Bud, what did you do with the ship?"

* * *

Shtarkle, shtarkle, little twink,
Who the heck you are, I think.
I'm not under the alchofluence of
inkohol,
Though some thinkle peep I am.

* * *

Voice on phone: "Hello, is this the Ithaca Gas Works?"

Professor: "No, this is the University Public Speaking Department."

Voice on phone: "Well, I didn't miss it by much, did I?"

* * *

Where'd y'awl git that Southern accent?

Honey-child, I'se been drinking outen a Dixie Cup.

* * *

Breathes there a man with soul so dead,
Who never to himself hath said,
"To hell with these studies,
I'm going to bed"

The tired worker plodded wearily home after a hard day at the factory. He had just sold his old car for junk, and his foreman had threatened three times in one day to fire him. When he reached home there was no aroma of supper cooking. A note informed him that his wife had left for good with the landlord's son. "That's the last straw," he said to himself in wild dismay. "One shot would end it all." So he got down the bottle and took one.

* * *

Overheard in the registration line recently: "Anyone that goes to a psychiatrist should have his head examined!"

* * *

A pink elephant, a green rat, and a yellow snake walked into Zinck's.

"You're a bit early, fellows," said the bartender. "They ain't here yet."

* * *

Prosecuting Attorney: "You mean to say you had sixteen beers and didn't move once from the table the night of the murder?"

* * *

The Home-Ec student taking an ag engineering course had not finished many assignments before she came up with the following definitions: A bolt is a thing like a stick of hard metal like iron, with a square chunk on one end and scratchings wound around the other. A nut is the same sort of thing, only opposite, being just a hole in a sawed-off hunk of iron with the wrinkles around the inside of it.

* * *

"Hell," said the devil as he picked up the phone.